2002 UPPER BASIN PALLID STURGEON WORKGROUP

ANNUAL REPORT

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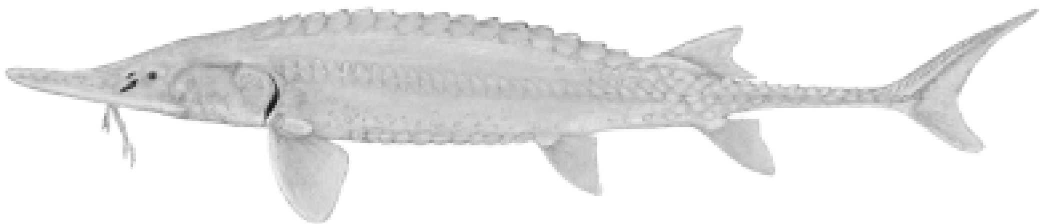
UPPER BASIN PALLID STURGEON RECOVERY WORKGROUP



2002 ANNUAL REPORT

The Upper Basin Pallid Sturgeon Recovery Workgroup is comprised of representatives from Montana Fish, Wildlife and Parks, North Dakota Game and Fish, South Dakota Game and Fish, U.S. Fish and Wildlife Service, Army Corps of Engineers, U.S. Geological Survey, PPL Montana, Western Area Power Administration, and Bureau of Reclamation.

The Upper Basin Pallid Sturgeon Recovery Workgroup coordinates and implements recovery actions for pallid sturgeon in Recovery Priority Management Areas 1,2, and 3, encompassing the Missouri and Yellowstone Rivers from the mouth of the Marias River to 20 miles upstream from the mouth of the Niobrara River. Recovery efforts in 2002 consisted of monitoring wild and hatchery reared sturgeon, continuation of the hatchery propagation program, and research into pallid sturgeon life history and habitat requirements.

This document contains the meeting notes from the Workgroup's 2002 and March 2003 meetings, as well as project reports from workgroup members, organized into field monitoring and research, propagation and fish health.

MEETING NOTES

Upper Basin Pallid Sturgeon Coordination Meeting – March 12, 2002

Fish Health – Propagation Protocol Meeting – June 2, 2002

Annual Upper Basin Coordination Meeting – December 4-5, 2002

Upper Basin Pallid Sturgeon Coordination Meeting – March , 2003

Upper Basin Pallid Sturgeon Coordination Meeting
March 12, 2002
Miles City, MT

AUGMENTATION PLAN

A sub-group met on March 11 to discuss the existing stocking plan, and modifications thereof. The group decided that we should develop a stocking plan for RPMA #1 and RPMA #2, and that the plan should outline stocking goals for the next 10 years, which is the anticipated remaining life-span of the existing wild population in both areas. Based on that, the group concluded that we should strive for an wild population of at least 1,000 age $\geq$15+ pallids in RPMA #1 (e.g., 1,000 age 15+ sturgeon in RPMA #1 by 2025), and a equally proportionate number in RPMA #2, based on available habitat. The group also concluded that we should strive for stocking an effective population (Ne) of between 120 and 160, based on the number of remaining wild adults, our ability to catch them, and hatchery limitations. Other assumptions agreed upon include: use a 60:40 male to female ratio for life tables; use survival estimates of 60% for age 0 to 1, 70% for age 1 to 2, 80% for age 2 to 3, 70% for age 3 to 4, 60% from age 4 to 5, 80 % for age 5 to 6, and 90% per year thereafter. Using these variables, the FWS was going to calculate a proposed stocking rate. The stocking rate in RPMA #2 will be based on the ratio of available habitat there to that available in RPMA #1. For example, there are 158 miles of habitat in RPMA #1, and 311 to 406 miles in RPMA #2, depending on whether you include available habitat above Intake Diversion. Therefore, the available habitat in #2 is 1.97 to 2.60 times that available in RPMA #1. So the stocking rate in RPMA #2 will be 2 to 2.6 times that calculated for RPMA #1.

STOCKING (2001 Year-Class Fish)

Available fish:

Miles City	Garrsion	Bozeman FTC	Garrison
407 + 175	1130	600	532
407 + 175	887	600	2171
407 + 175	879	600	2514
367 + 175	935	600	303
		300	618

Size	Size	Size	Size
6”	8-10”	6-14”	8-10”

Gardner: For research, need 2,274 fish, which would give a reasonable recapture rate of 3 and 4 year olds to sample and make conclusions.

RPMA #1 – use all Bozeman FTC fish as first priority

Unless disease results change, there are no others to stock. If disease results change, and iridovirus is detected in fish from above Ft. Peck, then could possibly use Garrison's 'Above Ft. Peck' fish to supplement.

Shovelnose – FTC still wants some to continue nutritional studies (above Ft. Peck).
Will coordinate with pallid capture efforts; also bring some adults into the hatchery (Bozeman FTC), stress them, and see if the disease can be expressed.

RPMA #2

The Miles City fish will likely only be 7 inches in length by June – too small to PIT TAG; Recommendation was to keep fish until big enough to PIT TAG and release.

Based on above, and hatchery capacity considerations, the following options were discussed:

- ♦ Hold adults outside, install more tanks inside, grow up 2001 fish to size to pit tag
- ♦ Hold adults inside and spawn them, stock out 2001 fish with coded wire tags
- ♦ No adults at MC, bring in eggs from Garrison, grow up 2001 fish for later stocking
- ♦ Use 2001 Garrison fish as the primary source for stocking RPMA2, and keep MC fish as back-up.
- ♦ Spawn all adult pallids at Garrsion – ship eggs to MC for rearing.

Discussion Point: Don't send all adults across the border, because there is a track record of not being able to bring fish back into Montana. Use both Miles City and Garrison.

Preferred alternative/Decision: Grow up Miles City fish to large enough size to PIT Tag; tag them, and stock them out. Bring some wild adults into the hatchery and spawn them – See Spawning Section Below.

In the interim, do tag retention study on smaller size fish; if they do retain PIT Tags, then smaller fish can be tagged and stocked. Ted Anderson, George Jordan, will help Bozeman FTC pit tag different size fish to look at tag retention

Tagging

RPA #1 – FTC fish – start pit tagging and stocking ½ in mid-April; ½ in August – use largest fish for stocking in April. That would help create some space now so that they could be thinned out.

- ♦ Mid-April - George Jordan, Bill Gardner, Randy Rodencol, Jim P., Ted Anderson, Brent Mabbott, will help PIT tag; Steve will write up a tagging protocol with data recording sheet. Measure and weigh at time of tagging. Check to see if has PIT tag at time of release.
- ♦ Tag remaining half in late July

RPA #2 – Miles City fish – when >10” or when can accommodate a PIT tag

- Garrison - 3,600 fish need to be tagged in mid-April – Matt Baxter, Dave Yerk, Steve Krentz
- Garrsion ‘Above Ft. Peck’ Fish – by early June – number to be determined
- Garrison ‘Below Ft. Peck’ Fish – if needed, by mid-June
- Garrison tagging (early-June) – Matt Baxter, Dave Yerk, 2 seasonals, Wayne Stancill person, lower basin persons, Herb, Matt.
- Miles City Fish (August) – Ft. Peck Crew, George, Region 7 crew.

Elastomer tag all fish – Steve K. and Herb B. will check into air-injection system, and possibly do all elastomer tagging at once, if possible.

ACOE will provide PIT tags

Do pit tag retention study immediately.

- **Use 20 each of 6, 8, 10, 12 inch fish; super glue hole on some (not hot glue); tag below dorsal fin; look at 30-day retention. If smaller fish retain tags and they don’t appear to be detrimental, then possibly smaller fish can be stocked**

Stocking

RPMA #1: Will release 2001 year-class pallids at 4 sites, the same 3 previously used sites plus Coal Banks: Marias, Coal Banks, Judith, Robinson Bridge. Bill Gardner will coordinate with FTC and Hatchery Bureau to tag, transport and stock. Stocking will occur as fish become available in Spring and Summer.

RPMA #2: Stock 2001 fish at Wolf Point, Culbertson, Sidney, and Fairview; possibly higher up in the Yellowstone in the Crane- Savage country. Fish will be stocked as they become available in Spring and early Summer.

Fall Stocking – If we get fish at Garrison up to taggable size:

- If at a taggable size by October 15, we will stock up to ½ of each eligible family group. Size to be released will partially depend on the tag retention study results. At least ?? inches
- Bozeman FTC fish may also be stocked in the fall (up to ½)
- Mike will work to get larger fish earlier in the year.

If find virus in fish at Bozeman in the next couple of months, MT would immediately convene the Fish Health Committee to get an answer whether Gavins fish (3-year-olds) could be stocked above Ft. Peck in RPMA #1.

SPAWNING 2002

RPMA #1

Bozewman FTC can hold 6 to 8 family groups of up to 500 (10”) fish

Stream side spawn in Jones Island Area – Start week of June 3rd

- ♦ Tech Center will set up tank
- ♦ Garrison will set up incubation tent
- ♦ Refuge has been notified and will provide bunk house space and 2-bay garage for cryopreservation RV
- ♦ 10 adult shovelnose will be taken to FTC for disease monitoring
- ♦ Bill Gardner and Brent Mabbott will provide 3 boats and crews; Dave Yerk could possibly contribute an additional crew – peak time is especially the week of June 10.
- ♦ Jim Peterson will oversee fish health protocol.
- ♦ Don't re-use males that have already been used

EVERY FISH WILL BE SAMPLED FOR GENETICS

<u>RPMA #2</u>

Capacity: Garrison – Two 20' tanks
Miles City – Two 12' tanks – possibly will be able to get larger tanks

- ♦ Garrison can hold 750 fish from each family if we do a 4 x 12 cross –
- ♦ Miles City can hold 4 family groups (potentially up to 8)

<u>Wild Adults to Collect and Spawn – Goal:</u>

- ♦ 1 Female: 2+ Males to Miles City (2 family groups) – potentially 2 females, 4 males
- ♦ 4 Females: 12+ Males to Garrsion (or up to capacity) – 12 family groups
- ♦ Eggs from two family groups (from 2 different females) will also go to Miles City so they have 4 family lots representing 3 females to raise – priority will be eggs from Area 1.
- ♦ If Garrison does not fill up, eggs from FTC could be sent to Garrison for rearing.
- ♦ Gavins will be considered as a back-up / supplement to Garrison. Jim P. recommends that eggs be shipped rather than fry.

EVERY FISH WILL BE SAMPLED FOR GENETICS

Dave Hendricks – Osho NFH in Missouri has requested surplus eggs if there are any.

Steve Krentz will discuss with Middle Basin group the possibility of a joint Upper-Middle Basin workgroup meeting.

Pallid Sturgeon Fish Health – Propagation Protocol Meeting

June 27, 2002 **Miles City, Montana**

<u>Purpose</u>: to bring together fish health and hatchery experts involved with pallid sturgeon propagation and recovery to discuss, develop, and refine pallid sturgeon health testing protocols, propagation protocols, and state import recommendations and requirements.

Summary of 2002 spawning efforts to date:

Above Ft. Peck – 1 male; 1 female (48lbs – new fish). The female died prior to spawning. Only a few viable eggs could be salvaged from her, resulting in 25 progeny

Below Ft. Peck (Garrison) – 1 female was crossed with 3 males, plus crossed with the upper male + crossed with cryopreserved male (5 family lots total)

- 1 female (68 lbs – red, swollen vent) = died; ovaries were very fatty; didn't seem to be good candidate for spawning
- 1 female – negative progesterone assay each time – eggs are flaccid – overripe

Miles City – 1 female crossed with 2 males + 1 cross with upper male = 3 family units

<u>Spawning</u>:

- Need to define requirements for bringing wild adults into a hatchery, such as what should be allowed if the hatchery is virus positive:
  Antibiotic regime – inject w/ nuflor or oxytet at capture and spawning (nuflor @.03 cc/ lb. and OTC @ .045 cc/ lb.)
- If from out of state, import permit required
- Adult handling and spawning methodologies
  - Hormones
    - LHRH – mammalian – results were not consistent
    - GNRH (ovaprim) – salmonid – Rick Barrows – probably not Ovaprim unless it turns yellow; however, several fish appeared to have stress response from Ovaprim
    - **Recommendation: run through whole spawning procedure using shovelnose**
- Outline injection methodologies (intermuscular injection in back is used since recommended injection into pectoral fin is traumatic to pallids as they use these fins a lot).
    - intramuscular in back; Rob sometimes also injects in ovary)
- Stress work published by Dr. Barton – talk to Herb
- **ENSURE ALL POSSIBLE EFFORTS ARE MADE TO MINIMIZE STRESS** – handling, disturbance, temperature, feed, water quality, etc. There are publications about

stress in pallid sturgeon. Although stress may not be observable, significant changes are detectable in blood chemistry because pallids are primitive.

- <u>Tubing process – vs. incision process</u> tubing
  - Tubing only used at GNFH. Mixed results with female survival. Tubing can cause septicemia if urinary duct sphincter is damaged or kidney can be damaged.
  - Herb: Concerned about bacterial infections with incisions.
  - If kidney damaged: 24-48 hours to death
  - If sphincter damaged: up to 5 days to death (urine in body cavity)
  - If fish survives 5 days, it will probably survive
    - Tubing is used to check condition of eggs and also to express eggs during spawning. Have not documented mortality due to tubing. DO NOT TUBE TO SPAWN – OK TO TUBE TO STAGE (Have to stage once per week)
  - Develop a Protocol for when the adults do not respond normally – if/then - for example, if they do not respond after x hours, then do a, b, or c
  - Look at records of stresses that fish were subjected to, to see if there are any commonalities
    - Gavins has not had the problems with spawning that they have had at Garrison (water temp, quality)
- Fish health testing, monitoring requirements to transfer eggs between hatcheries
  - Move eggs between hatcheries **rather than live fish**. If eggs fail, then look at fry.
  - Nonlethally sample adults prior to spawning.
  - Decision whether to accept eggs from a particular facility is contingent upon the health history of the facility. Need to develop culture strategies to address health concerns
- Obtain approval of receiving facility agency's and State's fish health staff
- MT recommends eggs be disinfected in iodine at receiving hatchery; could be water hardened in iodine as well (200 ppm)
- Import permit required from MT; courtesy call required in SD and MO
- FWS working on new fish health / inspection protocol
- Identify import/export/possession permitting requirements for eggs (state and federal)
- Develop recommended numbers of eggs/family unit that should go to primary and back-up facilities (may require discussion about available space and stipulations for moving live fish between facilities and/or across state lines)
  - 5,000 eggs = 500 progeny – another committee assignment
- Develop recommendation for allocating eggs (e.g., ensure primary facility has full complement before separating some out for back-up facility)
- Identify disposition of surplus eggs – define "surplus", timing of disposition

IF ADULTS DIE

- Have fish health person present at spawning (first priority)
- If fish dies, and fish health person is not present, immediately contact fish health center;
- **Fish health center will provide sample protocol + necropsy kit and instructions**.

TIMING STRATEGY FOR MOVING FISH, AND TECHNIQUES

- Protocol for holding adults and returning spawned adults to the wild
  - Fall collected adults were still held through the summer due to temp. concerns
  - 2002 spring collected adults – held for two weeks
  - Groups recommendation is to release them TO THE WILD as soon as possible
  - Regarding whether to radio transmitter or not:
    - Females: Keep water temp. down; If female looks OK after a couple weeks, then could radio tag. Decision is up to Hatchery manager - **<u>facility dependent – final determination to be made by hatchery manager</u>**
    - Males: Tag ASAP and release – sooner the better
- Gavins routinely dropped water temp down to <60 – relieves stress, stocked in fall (Fish handle and rehab better in cooler water, then stock in fall)

<u>Rearing</u>:

- Fish health testing and monitoring expectations, including reporting to and from fish health lab(s) throughout the year
- Routine testing – monthly sample (3 fish/family/every other month +)
- **REPORTING GOES TO EVERYONE; INCLUDE Hatchery Managers**
- <u>Recommended densities</u> (MAX - 0.5 lb./sq. ft.), flow rates, exchange rates, tank design, gas
- Miles City – were at 0.8 lbs/sq ft when gill disease and water quality were stressing them
- Flow indices/turnover rate - 2-4 times/hour (20 inches deep) – dependent on tank type, facility, fish size
- <u>Process for thinning out family groups</u> (selective vs. random thinning)
- MUST BE RANDOM – culling "runts" is the same as selective thinning
- <u>Timing and disposition</u> of culling/culled surplus fish
- <u>Recommendations and fish health requirements pertaining to moving live fish between facilities</u>
- **NOT RECOMMENDED….BUT IF YOU DO:**
- **RECEIVING FACILITY GET APPROVAL FROM APPROPRIATE USFWS REGIONAL FISH HEALTH CENTER, AND STATE IN WHICH RECEIVING FACILITY IS LOCATED**
- **IF HATCHERY HAS CLOSED WATER SYSTEM, SHOULD NEVER TAKE IN LIVE FISH**
- <u>WATER TEMPERATURES</u> - Recommended thermal regimes (based on facility capabilities), max/min temperatures for culture, acceptable rates of temperature change
- Gavins – 55 degree well water for incubation; 63-65 at hatching, up to 70+ once they start feeding (mid-July), 45 degrees overwinter. Below 45, they go off feed
- Miles City – keep at 63-65; never below 40 (40-44) during winter months (4 months), stay on feed year-round.
- Garrison – "natural thermograph" – but because reservoir is source of water, the "natural thermograph" is 2-3 months behind natural river temperatures.
- Bozeman – never went below 60°F – 63°F to 68°

- **DON'T LET THEM GO BELOW 45 ^{o}F; STOCK IN FALL IF CAN'T KEEP THEM ABOVE 45^{o} F.**
  - TEST DIFFERENCE BETWEEN FISH AT 34^{o} F vs. 45^{o} F
  - DON'T STOCK THEM WHEN THEY ARE IN BAD SHAPE; GIVE THEM TIME TO BUILD UP
  - STOCK ½ IN FALL AND ½ IN SPRING

- <u>NUTRITION</u> – feed type, duration, quantity, conversions, feed age & storage
  - Start with Biodiet fed (at ≥10% body weight) for 45-60 days.
  - After well on feed, stay on Biodiet at reduced rate (cut back by 25% **of what?**).

OR

  - After well on feed, feed Silver Cup at 5-10% body weight, year 2 feed at 3-5% body weight, after year 2 feed at ≤1% body weight.
  - Barrows-"Current diet doesn't permit rapid growth (producing big fish) with lean livers."
  - Start with Biodiet, switch at 45-60 days to Silver Cup when fish are feeding well, or cut back by 25% to 75% - if you do this, you probably could not grow these big enough to PIT tag and release in the fall
  - Miles City – fish were fed Biodiet to December, and exhibited bad livers; once they were switched to Silver Cup, their liver condition improved

- <u>TAGGING</u>
  - Does tagging take precedence over getting fish out?
  - ALL FISH MUST BE MARKED
  - 9 INCHES TO PIT TAG
- <u>Therapeutics</u> – Chemicals and dosages, prophylactic treatments, treatment calculations, treatment timing, treating round tanks

ITEMS REQUIRING FURTHER DISCUSSION
  - Other fish health concerns and expectations: e.g., parasites, fungus, overall condition
  - Handling techniques -
  - Growth rates – max/min range, optimum range
  - Fish disease – sources of stress, indicators of disease, treatments, disease avoidance
  - Dave Urdahl's shovelnose work
  - OTHER HATCHERY EXPERIENCE
  - INCORPORATE TROUBLE-SHOOTING/MONITORING PROTOCOL
  - Tips & techniques unique to pallid sturgeon propagation

<u>Stocking:</u>
- Fish health testing requirements (state and federal) prior to stocking (e.g., fish must be in X degree water for at least Y number of days prior to stocking, and must be actively feeding; Z number of fish must be tested prior to stocking)
- 59^{o} F – 68^{o} F FOR 10 DAYS – 60 FISH
- USE SUBSET OF FISH, BRING THEM UP TO TEMP., TEST THOSE
- Timing of stocking – expected survival, related fish health issues, size of fish

- Size requirements (culling vs. random)
- Tagging requirements
- Maximum tolerable thermal differences between source waters and receiving waters
- Procedure of how the Workgroup should discuss the findings on fish health for the development of recommendations for stocking
- Import/Export permit requirements for stocking hatchery-reared juveniles
- Hatchery hygiene protocol once fish are stocked out

Communication – Expectations

All workgroup members will be included on all communications pertaining to pallid sturgeon recovery, propagation, and fish health issues.

A sub-group will be appointed to further refine these discussion topics and to develop a propagation "best management practices" guide for pallid sturgeon recovery propagation.

Pallid Sturgeon Stocking Criteria

The following criteria has been established by Montana Fish, Wildlife and Parks for pallid sturgeon stocking in Montana waters.

June 2002

Montana Fish, Wildlife and Parks has evaluated the concerns associated with stocking of pallid sturgeon in Montana. The Missouri River sturgeon iridovirus (MRSIV) is known to be present in sturgeon at Gavins Point NFH and has been detected in the past at Garrison NFH. The virus had not been detected in Montana until it was detected in adult shovelnose sturgeon at Miles City SFH using a non-validated polymerase chain reaction (PCR) procedure in June 2001. Further confirmation of the virus in Montana was made June 21, 2002 when the virus was detected in yearling pallid sturgeon reared at Miles City SFH.

After reviewing test results from the sturgeon at Miles City SFH, Montana FWP recognizes MRSIV is present in wild sturgeon present in the Missouri River system below Fort Peck Reservoir. Even after extensive testing of sturgeon in the Missouri River above Fort Peck, the virus has never been detected above the dam. Therefore, unless the virus is detected in sturgeon collected above Fort Peck Dam, the Missouri River above the dam will be considered free of the virus, and no sturgeon from below Fort Peck Dam will be stocked into the river above the dam.

Since it has been determined that MRSIV does occur in Montana sturgeon in the Missouri River drainage below Fort Peck Reservoir, pallid sturgeon from sources at which the MRSIV has been detected may be used for stocking in Montana under specific criteria developed by Montana FWP. The stocking criteria must be met before an import permit will be authorized by Montana FWP for import of pallid sturgeon into Montana or stocking of pallid sturgeon from a Montana hatchery is allowed. Montana FWP will review each import and stocking proposal and issue final approval prior to stocking of any pallid sturgeon in Montana.

The following criteria have been determined by Montana FWP to be necessary to protect Montana's shovelnose and pallid sturgeon populations from disease associated with stocking of pallid sturgeon:

- Pallid sturgeon may not be imported or stocked into any Montana waters if:

    1. Sturgeon are exhibiting any signs of disease or unhealthy condition
    2. Sturgeon are experiencing any unusually high mortality
    3. Sturgeon are found to be infected with any pathogens or parasites not known to occur in Montana
    4. Sturgeon are found to be infected with any pathogen or parasite determined by Montana FWP to be a serious potential threat to existing Montana fisheries

- Prior to stocking, the sturgeon must be tested for MRSIV. Montana FWP will evaluate results of this testing in making a final determination on whether or not to allow the stocking. Fish with levels of virus excessively higher than may be present in wild sturgeon in Montana will not be approved for stocking in Montana. Testing must be conducted by the most accurate method available, currently histology.

- Since virus replication and expression of clinical signs of MRSIV may not occur in colder water temperatures, sturgeon must be held at temperatures of 15C-20C (59F-68F) for a minimum of 10 days prior to the final pre-stocking health inspection.

- Montana FWP will evaluate each pallid sturgeon stocking proposal on a case-by-case basis. Approval of the stocking will be made by the Montana FWP Fisheries Division Administrator after consultation with the Montana FWP Fish Health Committee. The FWP decision will be based on current health status of the sturgeon proposed for stocking, current health status of all lots of sturgeon at the hatchery source of the sturgeon, past history of sturgeon and the hatchery source, consideration of what alternate sources of fish are available, and the importance of the stocking to the pallid sturgeon recovery program.

- Montana FWP may place certain restrictions or conditions on the stocking proposal. Conditions may include a requirement to treat fish prior to stocking to remove bacteria or parasites. For example, FWP may require fish be treated with formalin prior to stocking to remove external parasites.

- Montana FWP will issue an import permit for each import proposal approved by FWP. Only sturgeon authorized by an import permit issued by Montana FWP will be allowed imported into Montana.

Comments/Thoughts from Rick Barrows:

To those who attended the meeting on June 27th.

Yesterdays sturgeon production meeting proved to be a good forum for information transfer since many different viewpoints were exchanged. There were many specific, important, points that I feel did not have enough discussion due to time constraints, and I hope these topics can be addressed at a later time. Although I thoroughly agree with the general concept of increasing communication and coordination of production efforts, I am still uncomfortable with strict standardization of methodologies due to the unique differences among hatcheries. No matter what procedures are agreed upon a good Hatchery Manager will not, and should not, use methods that produce an inferior quality fish. I believe the process should be more product (fish quality) rather than process (standard protocol) directed. However, development of an outline of procedures, and documentation of deviations from these procedures at each hatchery will greatly aid in improving the quality of hatchery-reared fish. It is only through such documentation that improvements in fish quality can be made with a species such as pallid sturgeon. This is because research done at a laboratory, such as a Technology Center, is not necessarily applicable to production hatcheries due to the same factors that make each hatchery unique (i.e. water supply and quality, tank size and design). Likewise, research by production hatcheries is not feasible due to the constraints of production (too much work, not enough people). Creative solutions to these limitations can be developed and will be proposed in the near future, but the bottom line is to maintain or improve the quality of the sturgeon being stocked back to the natural waters **today**, not when a research project is completed.

With these concepts in mind, I would like to make two proposals. First, a Cooperative Sturgeon Quality Evaluation Program be developed in addition to current fish health evaluations. This project could be coordinated by FTC personnel, and the exact details of such a program would be determined by consensus among the participating groups. Optimally, the evaluation would include assessment of the morphological (i.e. fin condition, body shape), physiological (i.e. liver lipid, visceral lipid, plasma cortisol), and behavioral (i.e. sensory abilities) characteristics of the fish. Sampled fish could be sent to the FTC for evaluation or if funding permits visits could be made to each facility in the fall and spring. Results of the evaluations would then be presented at the next meeting. Second, I propose an extra day be added to the December meeting for hatchery personnel to meet, review, and revise the information produced out of yesterdays meeting. I can't even believe I am recommending another day of meetings, but only through continued face to face communication can a strong, working document be developed.

I am interested in your comments on this or other topics discussed in yesterdays meeting.

Rick Barrows
Research Physiologist

Upper Basin Pallid Sturgeon Workgroup
Annual Meeting
December 3-4, 2002

POPULATION ESTIMATES

Kevin Kapuscinski (Montana FWP's new sturgeon biologist) recently did an analysis of the population estimates in RPMA No. 1 and RPMA No. 2.

- **For RPMA No. 1, the estimated population is 30 remaining adults**
- **For RPMA No. 2, the estimated population and 95% confidence limit is (94 - 166 - 305)**. Some limitations/assumptions that influence the calculation include:
  - Modified Schnabel multiple-census mark-recapture procedure
  - Assumption: natural annual mortality of 0.10
  - Some brood fish were stocked into RPMA#3 – how were they counted???
  - Since most effort is concentrated at the confluence of the MO/Yellowstone, the assumption re: random sampling is violated
  - 15 "recaptures" in database with no tagging (capture) history

- **Based on calculations of population size, the predicted year of extirpation is 2017** – assuming no fishing mortality and no upper age limit

Recommendation:

- Kevin recommended accepting the lower 95% CL of N=94 as the working population estimate for pallid sturgeon in RPMA#2. The resulting discussion recommended using the estimate plus/minus the confidence interval so we are not accused of skewing the numbers. Regardless, the new estimates indicate numbers are declining, and the population is very near extirpation.

- Aggressive measures must be taken to maximize the contribution of wild sturgeon towards recovery of the species

- Herb – **Need to use most prudent and proven methodologies to prevent mortalities of adult brood**

STOCKING NUMBERS

An analysis of the stocking program was conducted by MFWP. Based on that analysis:

- There has been no direct evaluation of the stocking program, so estimates of survival, and assumptions about mortality rates are just guesses.
- At current rates, the stocking plan will fail.
- Emphasis since 1995 has been capturing broodstock rather than sampling the population.

- Based on track record and stocking success, we don't have time to implement the existing stocking plan – the wild population will be gone before there are sufficient hatchery fish in the system.
- Based on the goal in the existing stocking plan, and if you stock 1,700 pallids in 2003, and 7,000 every year thereafter for 10 years, we would meet the goal for only 5 years. Stocking for only first 10 years won't cut it.
- The goal, as written, is mathematically impossible to achieve from a numbers standpoint.
- Need sustained effort of 4,000 to 5,000 hatchery-reared juveniles every year to reach goal.
- Stocking goal needs to have representation of conservation genetics. Therefore, WE NEED A GENETICIST to review the stocking plan.
- Need to also implement a sustained monitoring effort to make sure we know what is happening with the fish that are being introduced.
- Monitoring needs to be an integral part of any stocking program.
- Juvenile fish are not susceptible to our capture techniques.

STOCKING PLAN

There was a very lengthy discussion about stocking, including whether to focus on a minimum number to stock, or focus entirely on maintaining the maximum genetic diversity. **It was decided that a smaller Stocking Committee will look at revising the stocking plan.** They will incorporate suggestions from discussion of the night before as a starting point of issues needing to be addressed. They will also look at what the available habitat is within the RPMAs.

The committee will consist of: Steve Krentz (USFWS), Herb Bollig (USFWS), Rob Holm (USFWS), Bob Snyder (MFWP), Bill Gardner (MFWP), Kevin Kapuscinski (MFWP), Fred Ryckman (NDGF), Brent Mabbott (PPL).

The stocking plan/stocking numbers will be analyzed based on the combination of the following variables:

Numbers and sizes needed to reach goal
Genetic Considerations
Hatchery Capacity

Kevin will redo numbers; Herb will contact geneticist; committee will meet in late January/early February. Hope to have final draft by March meeting; then will go through internal USFWS Section 7 consultation.

HATCHERY CAPACITY

As part of the discussion about stocking numbers, it is necessary to know what the capacity of the different hatchery facilities is so we know how many fish/family groups we can rear at the hatchery facilities.

Hatchery managers were asked to estimate the capacity of the hatcheries to rear and hold 9-inch fish, based on a maximum recommended density of 0.50 lbs/sq. ft of tank space.

Facility	Capacity	Current Inventory
Gavins	6,000 (9 families)	14,500 (5 families)
Garrison	4,500	7,700 (4 families)
Miles City	3,000	4,800 (1 family)
Bozeman FHC	4,000	0

There was concern brought up about the Garrison fish because they are already >9 inches in length. Therefore, this facility is exceeding the recommended densities. The group recommends that the fish be thinned so they do not exceed the recommended maximum density of 0.50 lbs/sq. foot of tank space.

Need strategy for deciding how to divvy up efforts between facilities

OTHER STOCKING OPTIONS

There was a lengthy discussion about other options that can be implemented to increase stocking numbers given hatchery capacity limitations. A concern is how you would identify the origin of fish that are captured many years later, which is why, to date, all fish have been PIT-tagged:

It was noted that we have had fish both in the brood stock and the wild that have lost their PIT tags – especially after 4-5 years – this is not a fail-safe method.

Options for utilizing other sizes of fish and other tagging techniques include:
Larval – reserve as a future option
Fingerlings – issue: identification of source (tagging)
  Can be marked using:
    Elastomer tag (3-4 inches) – wait until they are 4 inches (early September)
    Blown on elastomer -
    Coded wire - 3 inches or >
    OTC – difficult to recover the mark – sacrifice or large fin clip
    Genetic baseline
    Heat marking – needs to be researched to see if it can show up in fin rays
    Scute removal – would need to determine affects on the fish.

6 to 9 inchers – if they are already that big going into winter, save them until spring, and let them go when conditions are better. vs. if they are surplus, go ahead and put them out in an experimental manner. Recommend they be double tagged with elastomer and coded wire. Should be batch marked for identification (coded wire and elastomer)

The ACOE indicated they want clearly defined marks on fish in RPMA#2 in order to evaluate flow releases. It was noted that if we stick with >6 inch fish, we can double mark them. If we use smaller fish, we don't know if they will retain those marks, and so should not risk it. Many in the group disagreed with this position.

Another option discussed would be to put tagged surplus fish into the Yellowstone river above Intake, looking at entrainment, and see what they do (Cindy Williams – BuRec). Would need to tie monitoring and evaluation to any such release.

Bill Gardner questions whether the currently stocked fish are making it. Based on 31 recaptures, he doesn't feel confident that using 9-inch PIT-tagged fish is necessarily working.

There was a recommendation that we can meet the stocking goal by using the larger fish, and still stock out fingerlings marked with elastomer tags. Elastomer tags – have a life span of 5-7 years

The Stocking Committee will include an evaluation of the above suggestions in the stocking plan.

Once plan is modified, the FWS must consult on the revised draft.

GENETICS

U.C.- Davis says there is real good genetic diversity in the adults that have been used for the hatchery program and their offspring (based on what has been sent and analyzed)

HABITAT

It was discussed during the meeting that the USFWS considers stocking as a short-term goal – and that there are bigger habitat issues that need to be addressed:

Spring flows (out of Canyon Ferry and Ft. Peck Dams)
Dam operations
Fish passage (e.g., Intake Diversion on the Yellowstone River)

Stocking, flows, habitat limitations are all things that should be looked at in relation to whether RPMA#1 would be recoverable.

Workgroup should draft a letter from the Workgroup to the Bu Rec stressing the need for flushing flows for pallids if it is important. Specific issues and recommendations would be needed.

Habitat – prioritization scheme (discussed below) will be used by agencies to address issues and prioritize work. Group recommended that a letter be sent to the Bu Rec area manager (Susan Kelly) and MaryAnn asking them to begin addressing BuRec issues.

Notification should be provided to states re: instream flows and habitat needs

Water depletions should be added to the priority list

Full flow test is under the Master Manual operation; mini-test is being pulled out by the ACOE and not being done under the manual – ACOE is handling the mini-test independent of that.

It was suggested that a HABITAT TEAM be appointed to identify habitat priorities. This will be done once the stocking and propagation committee reports are completed.

FISH HEALTH

PCR test for the iridovirus – where are we? Virus is very difficult to grow cultures. Validation study used 100 fish; 7 tissues per fish showed that the test was making false positives and was missing histologically positive fish. Are now looking for a DNA polymerase gene. U.C.-Davis will give it an intensive effort over the next two months, and if it doesn't work, we will have to rely on histology. Assumption was that the virus was similar to white sturgeon iridovirus – may be a wrong assumption.

Collected 50 shovelnose and tested them, as well as the pallids that were collected above Ft. Peck for the virus – none have tested positive for the virus.

The original shovelnose positive results from RPMA#2, which tested positive for iriovirus via PCR, are invalid since the PCR test has proven to be invalid.

RPMA#1 – FWP has agreed that eggs from Miles City could be transported to Bozeman and reared, although no decision has been made whether or not stocking of those fish into either RPMA would be allowed.

Question: Is it worth the time and effort to raise them if we can't stock them? One answer would depend on whether there are lots of family units. If we need increased capacity to have more family units, even if for only stocking in RPMA#2, it may be worth using the Bozeman FTC.

Need to continue to go through the motions of collecting shovelnose and testing to see if we find it in the wild in RPMA#1.

One option would be to use shovelnose in live cars in the river, hold them for at least a month, and test them periodically. Debris in the river would make this labor-intensive, although possibly CRM refuge staff could assist.

Fish Health issues includes more than just the virus: virus attacks sensory epithelium of fish – and may inhibit their ability to find food. Also need to look at and evaluate them for liver condition, status of skin (more than just is the virus present or not)

Liver condition – when it started rearing its ugly head, Gavins adjusted the diet to include more Silver Cup vs. Biodiet.

Gavins and other hatcheries would like to see reports in writing re: liver conditions.

Garrison – negative for virus;
Miles City - negative for virus;
Gavins – positive for virus; same family as at Miles City and Garrison

Need to pool the 4 facilities and analyze their propagation regime to see what works best – Mike Stemple

Towards that recommendation, a hatchery propagatation committee was appointed. They will review and make recommendations towards an acceptable hatchery propagation regime. The committee will be chaired by Bob Snyder, and will include hatchery managers (Rob Holm, Mike Rhodes, Herb Bollig, Ron Zitzow) and fish health specialists (Jim Peterson, Crystal Hudson, Beth MacConnell).

Montana Fish, Wildlife and Parks identified fish health criteria for stocking pallid sturgeon into Montana. Those criteria are as follows:

The following criteria have been established by Montana Fish, Wildlife and Parks for pallid sturgeon stocking in Montana waters.

June 2002

Montana Fish, Wildlife and Parks has evaluated the concerns associated with stocking of pallid sturgeon in Montana. The Missouri River sturgeon iridovirus (MRSIV) is known to be present in sturgeon at Gavins Point NFH and has been detected in the past at Garrison NFH. The virus had not been detected in Montana until it was detected in adult shovelnose sturgeon at Miles City SFH using a non-validated polymerase chain reaction (PCR) procedure in June 2001. Further confirmation of the virus in Montana was made June 21, 2002 when the virus was detected in yearling pallid sturgeon reared at Miles City SFH.

After reviewing test results from the sturgeon at Miles City SFH, Montana FWP recognizes MRSIV is present in wild sturgeon present in the Missouri River system below Fort Peck Reservoir. Even after extensive testing of sturgeon in the Missouri River above Fort Peck, the virus has never been detected above the dam. Therefore, unless the virus is detected in sturgeon collected above Fort Peck Dam, the Missouri River above the dam will be considered free of the virus, and no sturgeon from below Fort Peck Dam will be stocked into the river above the dam.

Since it has been determined that MRSIV does occur in Montana sturgeon in the Missouri River drainage below Fort Peck Reservoir, pallid sturgeon from sources at which the MRSIV has been detected may be used for stocking in Montana under specific criteria developed by Montana FWP. The stocking criteria must be met before an import permit will be authorized by Montana FWP for import of pallid sturgeon into Montana or stocking of pallid sturgeon from a Montana hatchery is allowed. Montana FWP will review each import and stocking proposal and issue final approval prior to stocking of any pallid sturgeon in Montana.

The following criteria have been determined by Montana FWP to be necessary to protect Montana's shovelnose and pallid sturgeon populations from disease associated with stocking of pallid sturgeon:

- Pallid sturgeon may not be imported or stocked into any Montana waters if:

    - Sturgeon are exhibiting any signs of disease or unhealthy condition
    - Sturgeon are experiencing any unusually high mortality
    - Sturgeon are found to be infected with any pathogens or parasites not known to occur in Montana
    - Sturgeon are found to be infected with any pathogen or parasite determined by Montana FWP to be a serious potential threat to existing Montana fisheries

- Prior to stocking, the sturgeon must be tested for MRSIV. Montana FWP will evaluate results of this testing in making a final determination on whether or not to allow the stocking. Fish with levels of virus excessively higher than may be present in wild sturgeon in Montana will not be approved for stocking in Montana. Testing must be conducted by the most accurate method available, currently histology.

- Since virus replication and expression of clinical signs of MRSIV may not occur in colder water temperatures, sturgeon must be held at temperatures of 15C-20C (59F-68F) for a minimum of 10 days prior to the final pre-stocking health inspection.

- Montana FWP will evaluate each pallid sturgeon stocking proposal on a case-by-case basis. Approval of the stocking will be made by the Montana FWP Fisheries Division Administrator after consultation with the Montana FWP Fish Health Committee. The FWP decision will be based on current health status of the sturgeon proposed for stocking, current health status of all lots of sturgeon at the hatchery source of the sturgeon, past history of sturgeon and the hatchery source, consideration of what alternate sources of fish are available, and the importance of the stocking to the pallid sturgeon recovery program.

- Montana FWP may place certain restrictions or conditions on the stocking proposal. Conditions may include a requirement to treat fish prior to stocking to remove bacteria or parasites. For example, FWP may require fish be treated with formalin prior to stocking to remove external parasites.

- Montana FWP will issue an import permit for each import proposal approved by FWP. Only sturgeon authorized by an import permit issued by Montana FWP will be allowed imported into Montana.

PROJECTED 2003 STOCKING

Based on the numbers and family units of pallid sturgeon currently in the hatcheries, and the recommended stocking numbers in the existing stocking plan, it is projected that stocking would be as follows:

425 x 4 families = 1,700 (RPMA #2)
80 x 5 families = 400 (RPMA #3)
3,000 x 4 families + 800 = 12,800 (RPMA #4)

<u>One option for excess fish is to do performance/fitness tests in the hatchery</u>

PROPAGATION DISCUSSION

At a June 2002 meeting called to specifically discuss propagation issues, many items were discussed including recommended thermal regimes, holding densities, feeding regimes, etc. Many of these were discussed again:

Heat exchangers at Garrison will not be installed until next year – this is a continual problem that the workgroup has repeatedly brought up with the USFWS. Funding for this was provided by WAPA in 1999.

Garrison won't keep their 2002 year-class sturgeon above ambient temperature

Gavins always wants their pallids to stay on feed, so they keep their digestive systems going by feeding only up to 1/10 of a percent of body weight.

RANGEWIDE STATUS

There was a brief review of the overall rangewide status:

RPMA #1 – river miles _____; estimated population – 30 wild adults; no stocking currently due to disease issues
RPMA #2 – river miles______; estimated population – 166 wild adults; propagation program
RPMA #3 – river miles_____; estimated population - ??
RPMA #4 – river miles______; 800/mile in some locations. Overall population ???; some recruitment, although relying heavily on stocking. Because of habitat limitations (size of river, depth) there is very little ability to determine population size. Hybridization is a problem.
RPMA #5 – essentially the same as 4 (except Mississippi). Fish from RPMA #4 are moving into RPMA #5, and visa versa. Reproduction has been found in RPMA #4, recruitment in RPMA #5. Because of habitat limitations (size of river, depth) there is very little ability to determine population size. Hybridization is a problem.

RPMA #6 – 1,800 – 2,400 in the Atchafalaya River (hybridization is an issue); oldest fish in the lower Mississippi appears to be about 16 years old and about 10 pounds. Wide range of sizes up to 10-12 pounds.

In middle and lower basins, commercial and illegal harvest is a concern due to caviar prices. Poaching has been increasing in response to the collapse of the beluga sturgeon in Russia

Lower Basin – Looking at Atchafalaya more heavily – attempted to capture 50 sturgeon/month
1,800-2,400 in this stretch – hybridization is a concern with shovelnose. Genetics/hybridization is a threat; density of hybrids is increasing while density of pallids is also increasing.

Platte River – quite a lot of work going on; drought has been impacting that system.

Would like to see a funding package put together outlining long term and fixed costs such as propagation and research and monitoring. e.g., This is what it costs for pallid sturgeon recovery in the upper basin

RECOVERY PLAN

Original recovery Plan was written in 1993. In 2000 it was reviewed, and the team felt the goals were still relevant. Will be looking at updating the recovery plan. FWS is looking at different alternatives to recovery planning. At point now where we can quantify recovery in a more measurable way, which can be incorporated into the goal. May also be able to look at each RPMA separately.

In 2004, we will look into pulling the three workgroups together – possibly in Missouri in June.

Recovery Team would be the entity to do the Recovery Plan update. Would probably start in 2004. Update would be much more specific for each RPMA, would include specific recovery criteria for each, and tasks to accomplish for each.

PRIORITY ACTIONS

The priority actions list assembled by Steve Krentz was discussed. If there are things that need to be clumped, or ways to make it more effective let Steve K. know. The list is a combination of what folks think is needed for recovery and where funding should be directed. It is a picture of what is needed for recovery in the upper basin.

DATABASE / DATA SHEETS

Current Database – The USFWS has established a database with all sturgeon capture data. However, there are 15 recaptures that have no original capture data, and one tagged fish with no data.

Standardized Database or Data Sheet – So that data is collected and reported consistently, the following was agreed upon:

Length, weight, temperature should all be in metric units.
Use lat-long in decimal degrees for location coordinates.
All should be done according to standardized data sheets.
Everyone should be measuring and tagging the same according to the protocol – see handout.
Genetics should be collected on all fish, and photographs should accompany the genetic sample.
Suggestion – put protocols, plans, and data sheets on a web page that can be downloaded.

NEXT MEETING

December 3, 4, 2003

Upper Basin Pallid Sturgeon Workgroup

March 20, 2003

Meeting Notes

The first part of the meeting was spent clarifying workgroup participant's thoughts about what the objectives of the workgroup are, and identifying actions and strategies to address those objectives. Specifically, workgroup participants were asked to respond to the following questions:

- What are the goals and objectives of this workgroup?
- What are the worst possible outcomes of not working together to accomplish goals and objectives?
- What are the best possible outcomes of working together to accomplish goals and objectives?
- What strategies and actions can we do to achieve the best possible outcomes?

Workgroup participant's answers were combined into collective statements. Those statements are as follows:

What are the goals and objectives of this workgroup?

The objectives and goals of this group are to:

1. Recover self-sustaining populations of pallid sturgeon
2. Meet needs of pallid sturgeon
3. Prevent extinction
4. Repopulate historical range
5. Implement decisions of the group in the field
6. Operate as a group, not individually
7. Share and allocate limited resources
8. ID the pallid sturgeon needs
9. Identify current status of pallid sturgeon
10. Meet goals of recovery plan
11. Update recovery plan
12. Identify and carry out recovery suggestions
13. Determine what is limiting recruitment
14. Limit disease concerns and the virus problem
15. Be consistent between recovery areas
16. Influence policy to address genetics, diseases and plans
17. Communicate management decisions
18. Bring expertise together
19. Share information as we learn, and think outside the box

What are the worst possible outcomes of not working together to accomplish goals and objectives?

The worst possible outcome of not working together to accomplish goals and objectives include: extirpation, extinction in RPA 1, 2, 3, and extinction and loss of a resource, of a native historic species.

We have concerns for loss of fish that potentially could be used in recovery efforts. We lose the fish by losing fish to other recovery areas due to maladies.

The loss of this species will result in the breakdown of partnerships, including Congress. The loss of credibility and fracture of relationships (coordination efforts) in that FWS has final say resulting in a single decision maker when it should be a shared responsibility between partners/workgroups.

As pallids are an indicator species and linked to ecosystem recovery, this "canary" species implicates impact on recovery of other T&E species such as birds, mammals, plants and associated flows.

What are the best possible outcomes of working together to accomplish goals and objectives?

The Best Possible Outcomes of working together are accomplishing goals and objectives for recovery, self-sustaining populations (of pallid sturgeon), and delisting. The recovered and restored pallid sturgeon populations will establish self-sustaining population(s). Furthermore, we reiterate self-sustaining populations of pallids. With the rehabilitation of Missouri River ecosystem, flow and habitat restoration will be accomplished. By solving the problem of dams and land use policies, native communities will benefit, and the ecosystem will be recovered to a point that new species aren't listed.

If the group is successful, this brings credibility and cooperative partnerships that are efficient at implementing recovery plans. This, in turn, will build agency credibility and positive public attitude and increased perceptibility. Team unity will improve interagency relationships, including coordination and cooperation with trust and respect for each other. Good science will bring group credibility.

Information gained from this effort will be used for the next crisis or issue. This will generate excitement (like family feud) for more money for threatened/endangered species. Future generations will know what a pallid sturgeon is, and the public won't ask: if a species isn't useable to the angler, why waste the effort? School children and the Congress will appreciate biodiversity and land use issues resulting in greater appreciation and more dollars.

Many anglers will have an opportunity to catch a large fish, and it will be almost impossible to cast a worm without catching a pallid sturgeon. That will result in so many fish that we could go into the caviar business. A sport fishery will lead to economic development. Ultimately we will move on to the next species and Montana is the caviar capitol of the world

This will result in no more pallid sturgeon meetings!

What strategies and actions can we do to achieve the best possible outcomes?

Strategies and actions to achieve the best possible outcome include new techniques for decision making, better coordination, implementation of action items, accountability, and meeting deadlines.

The recovery effort should make the most of our opportunities, and base decisions on science. Individuals must be open minded and set their egos aside, so that group decisions are made and implemented. Improve the decision making of the group by utilizing a core group of voting people (no one man has veto power). Develop a better process for agreeing. The process needs sound leadership with capabilities to coordinate and implement unbiased decision-making for the recovery effort.

The revised recovery plan should incorporate field information and observations when making adjustments to make it a more flexible, dynamic, working document.

For the recovery of the pallid, research efforts need to continue with field, health, and hatchery input. Also, be realistic and listen to what data is telling us as opposed to what we want it to say.

Develop criteria for producing best quality fish for recovery. More aggressive stocking to perpetuate through the bottleneck and stocking more fish while addressing habitat needs. There must be consistent stocking and a willingness to take risks.

Secure annual funding to accomplish various tasks, get resources to those that are doing the work, provide adequate resources and funding to accomplish tasks, mo wada (more water), and funding.

There was discussion about some of the issues and concerns expressed by the group. Some of those include whether there are specific issues with individuals or the USFWS. One specific item that came up was the role of the recovery team vs. this workgroup, and how it appears the recovery team is being used as an excuse by the USFWS to not accept recommendations of the workgroup. There was also discussion about the role of the fish health experts in evaluating overall health of pallids at the different hatcheries, and how their information seems to be brushed off or ignored. Stocking numbers also were brought up again.

To address many of the issues that came out in the answers to the questions above, Ken McDonald has requested that Western Division of AFS conduct an independent review of the whole upper basin recovery program, and make recommendation to improve the recovery efforts of the upper basin. There was agreement by the workgroup that this would be a very good thing. WD-AFS has agreed to take this on – they will likely appoint individuals with expertise in fish health, propagation, and population ecology to review all aspects of the upper basin program. It is hoped that this can be completed during 2003. Funding to help pay for the review will be requested from each of the agencies.

The discussion then moved on to logistics for the upcoming field season – specifically, how many of the 2002 progeny will be released in the different recovery management areas, how many adults should be targeted for capture in 2003, which facilities they should be taken to, and projected stocking needs for 2004.

2002 Progeny Stocking

RPMA #1 – There are currently no 2002 hatchery-reared pallids that are authorized to be stocked into RPMA #1. All existing progeny came from RPMA #2, and because of ongoing concerns about the iridovirus, RPMA #2 fish cannot be stocked in RPMA #1 where the virus has never been detected.

RPMA #2 – Under the current stocking strategy, up to 2,330 progeny per female may be stocked into RPMA #2. Gavins, Garrison, and Miles City hatcheries all have 2002 year-class progeny from the same female, although Miles City progeny all were from the same male, whereas the progeny at Garrison and Gavins resulted from crosses with four different males. The existing inventory consists of crosses all from the same female, so only up to 2,330 may be stocked. Fish to be stocked in RPMA #2 will come from Miles City and possibly Gavins (pending Montana Fish Health Committee approval), and will be stocked in July or August – post-runoff. All will need to be PIT-tagged. Because of ongoing concerns about the quality of the fish at Garrison, and the inconsistent and contradictory reports about the overall health of pallids at that facility, Montana Fish, Wildlife and Parks will no longer allow pallid progeny from that facility to be stocked in Montana until an accepted assessment and fish health reporting protocol is developed and followed.

RPMA #3 – Up to 330 progeny per female can be stocked in RPMA #3. These will come from Gavins Point, and representatives from all four crosses will be stocked.

2003 Spawning Efforts

RPMA #1 – Bill Gardner, Brent Mabbot and crew will attempt to capture at least one female for streamside spawning in RPMA #1 in June. Bozeman FTC will again provide the tank. If eggs can be collected, they will be taken to Bozeman FTC as the primary facility, and to the other hatcheries as back-up as space allows.

RPMA #2 – There was a discussion about whether some or all of the adults captured in the confluence area could be held and spawned streamside, to reduce potential threats from the hatcheries. It was concluded that it would be too difficult logistically to do so. There was hesitation by members of the group to allow any adults to be taken to Garrison due to concerns about that facility. Many in the workgroup are not supportive of continuing to use Garrison. A point was made that rather than walking away from that facility, problems and issues need to be identified and corrected. If they are not or can't be, then it shouldn't be used, especially as a primary facility.

After a long discussion, it was agreed that the first two females and 4 males would be taken to Miles City for spawning, and up to three additional females could be taken to Garrison IF Garrison agrees to follow recommended protocols such as those resulting from the June 2002 meeting (e.g., 0.5 lbs./sq. foot of tank space is maximum density they can be held at). Any additional holding, spawning, and rearing recommendations, especially pertaining to fish health, should be forwarded to Garrison prior to the spawning period. The propagation committee appointed in December will be working better develop a propagation protocol to help this process.

In addition to the progeny from RPMA #1, Bozeman FTC agreed they could take eggs and rear progeny from up to 3 females from RPMA #2, and could keep those isolated from the RPMA #1 progeny. The group recommended that Bozeman do so. Therefore, the group recommends that Bozeman take enough eggs from the first three females to be able to raise 2,330 nine-inch offspring per female for RPMA #2, as well as raise enough progeny from the female captured in RPMA #1 to meet stocking needs in both RPMA #1 and #2. This needs to be reviewed by the Montana Fish Health Committee, and assurances are desired that if the RPMA #2 fish test positive for the iridovirus, that wouldn't affect the ability to rear and stock the RPMA #1 fish in RPMA #1, provided the two groups (RPMA #1 and #2) are kept separate from one another.

Attempts to capture adults in the confluence area will occur in April, following the same protocols as last year.

Gavins indicated they would not be able to rear any 2003 year-class pallids due to space limitations. Therefore, Bozeman, Miles City, and Garrison will be the rearing facilities.
We still need to determine the capacity of the different facilities for rearing different crosses, and total numbers they can rear. Only eggs should be moved between hatcheries. It was also mentioned that the upper basin is the primary source of progeny for stocking in RPMA #4. The workgroup agreed that RPMA #4 stocking needs must be incorporated into the workplans of the upper basin so we can plan accordingly, and so only the number needed for meeting stocking goals are kept in the hatcheries. Stocking should be based on fish per mile, similar to that used for RPMAs #1-3.

Projected Stocking Needs/Stocking Plan

There was continued discussion about the numbers of progeny that could and/or should be stocked. A draft stocking plan was briefly discussed, and based on that plan, 2,330 progeny per female can be stocked in RPMA #2. Stocking numbers in RPMA #1 and #3 will occur at the same number per mile, and so will be adjusted based on the number of river miles in each area. It was recommended that RPMA #4 stocking follow this same logic so there is consistency across the range. It was also recommended that the hatcheries raise only enough fish to meet stocking purposes so that densities are minimized and hopefully stressors are reduced.

There was concern raised that the stocking plan doesn't necessarily reflect the thoughts/agreements of all of the Committee members who were working on it. Therefore, it was decided that comments on the draft plan would be submitted to Ken McDonald by April 21. McDonald will forward them on to Steve Krentz for incorporation into a final plan. It was repeated that if people have problems with the numbers in the plan, they must provide justification (e.g., better survival estimates) to change the numbers. The USFWS has to present a strong rationale for how the final stocking numbers were derived.

There was a recommendation to allow stocking of smaller fish such as fry or fingerlings, or enabling use of remote site incubators. Most participants agreed that it is important to be able to identify the parental origin of such fish in order to evaluate recovery efforts. If it is possible to identify them using genetics, then that should be documented so this option can be considered, and included in the stocking plan.

Comments pertaining to the stocking plan brought up at the meeting included:

- look at and include in the plan imprint/fry stocking
- consider other tagging alternatives
- use genetic markers to identify parental origin
- use "surplus" fish to stock above Intake Diversion on an experimental basis
- look at stocking numbers and how those were developed based on carrying capacity and survival estimates.

Fish Health

There was a discussion about the health of pallid progeny at the different facilities, and a handout prepared by the Bozeman Fish Health Center with photos illustrating the affects of the virus and fatty livers. Fish that are breaking with clinical levels of the iridovirus demonstrate degenerating or total lack of sensory cells. It is unknown if they can regenerate these cells, or if there is permanent damage which would hinder survival in the wild. Regarding fatty livers, those with a +5 ranking suffer permanent cell damage. Wild fish generally had +3 livers, pallid progeny at Miles City and Gavins had +4 livers, and some of the fish examined from Garrison had +5 livers. It was reiterated by Montana Fish, Wildlife and Parks that all hatcheries should strive for the best fish possible, and that only healthy fish should be stocked. Health must include more than just whether positive or not for the iridovirus. It must take into account all variables that contribute to a fish's health, and therefore its potential to survive. A fish is not healthy just because it is alive.

Next Meeting

The annual meeting will be held on December 3-4 in Miles City, Montana.

RESEARCH AND MONITORING

Pallid Sturgeon Research and Recovery Efforts in the Upper Missouri River, Montana (RPMA #1), July 1, 2001 through June 30, 2002. Bill Gardner, Montana Fish, Wildlife and Parks, Lewistown, Montana

2002 Pallid Sturgeon Research and Recovery Efforts in the Upper Missouri River, Montana (RPMA #1), Bill Gardner, Montana Fish, Wildlife and Parks, Lewistown, Montana

Lower Missouri and Yellowstone Rivers Pallid Sturgeon Study – 2002 Report. Kevin Kapuscinski and Matthew Baxter, Montana Fish, Wildlife and Parks, Fort Peck, MT.

Population Abundance Estimation of Wild Pallid Sturgeon in Recovery-priority Management Area #2 of the Missouri and Yellowstone Rivers During 1991-2001. Kevin Kapuscinski, Montana Fish, Wildlife & Parks, Ft. Peck, Montana. October 18, 2002.

Fort Peck Reservoir fish inventory and pallid sturgeon. Mike Ruggles, Montana Fish, Wildlife and Parks, Ft. Peck, Montana

Fort Peck Flow Modification Biological Data Collection Plan. Summary of 2002 Field Activities. Patrick J. Braaten, U.S. Geological Survey Columbia Environmental Research Center, and David B. Fuller, Montana Fish, Wildlife and Parks, Fort Peck, MT

Movements and Habitat Preferences of Adult Post-Spawn Pallid Sturgeon, 2002 Progress Report, March 17, 2003. Wade L. King and Ryan H. Wilson, U.S. Fish and Wildlife Service, Missouri River FWMAO, Bismarck, North Dakota.

Interim report on the habitat use and movements of pallid sturfeon in Lewis and Clark Lake, Missouri River, South Dakota. Prepared by the US Fish & Wildlife Service, Great Plains Fish and Wildlife Management Assistance Office, Pierre, SD

2002 Summary Report of Work Conducted by the Missouri River FWMAO on Missouri-Yellowstone River's Pallid Sturgeon. Steven Krentz, Ryan Wilson, Wade King, Missouri River FWMAO, U.S. Fish & Wildlife Service, Bismarck, ND

Corps of Engineers Pallid Sturgeon Activities in 2002

Bureau of Reclamaton 2002 Summary

Pallid Sturgeon Research and Recovery Efforts in the Upper Missouri River, Montana (RPMA #1)

July 1, 2001 through June 30, 2002

Bill Gardner
Montana Fish, Wildlife and Parks
Lewistown, Montana

RESULTS:

The study objective was to evaluate the pallid sturgeon reintroduction program in the Recovery Priority Management Area 1 (RPMA-1). A total of 758 hatchery-reared (HRJ) yearling pallids (1997 year-class) were released into RPMA-1 during the summer, 1998. The pallid sturgeon augmentation plan called for annual stocking of juvenile pallids for six consecutive years, at which time the plan will be evaluated based on its effectiveness. No stocking of juvenile pallid sturgeon occurred again in 2001 because of continued concerns about a virus that was detected in the pallid hatchery. Therefore, this report deals with further evaluations of the 1997 year-class and a report on propagation efforts during 2002.

The study area is a 168-mile reach of the Missouri River immediately upstream of Fort Peck Reservoir (Figure 1). Drift netting and angling were used to sample the 1997 year-class release. Additionally, trawl sampling was conducted in the study area for assessing wild pallid and shovelnose sturgeon reproduction.

Juvenile pallid sturgeon netting survey:

It is important to evaluate the success of the pallid sturgeon augmentation program so that problems can be resolved early on in the program. Stocking densities, age of stocked fish, acclimation and growth of stocked fish, and location of release sites are all important aspects for evaluating survival and ultimately recruitment of the released HRJ pallid sturgeon.

A total of 758 hatchery-reared juvenile (HRJ) pallid sturgeon (1997 year-class) were released in 1998 at 3 locations of the Upper Missouri River. The average weight of these yearling fish was 0.17 lbs. and all were PIT-tagged. No other pallid releases have subsequently occurred because of the concern about the Missouri River Sturgeon Irido Virus (MRSIV) discovered in the pallid sturgeon hatcheries since 1999. Therefore, only this initial pallid sturgeon release has been evaluated over the past 4 years in RPMA #1.

Attempts were made to capture the HRJ pallid sturgeon by drifting small mesh trammel nets and by angling. A total of 8 HRJ pallid sturgeon were captured; 7 by netting and 1 by angling (Table 1). All of the HRJ pallid sturgeon were captured in the Robinson Bridge Section (RM 1907.2 - 1920.9). Additionally, a total of 2,005 fish, representing 20 species, were sampled while netting throughout the study area (Table 2). Shovelnose sturgeon (SNS), goldeye, shorthead redhorse and longnose sucker dominated the catch comprising 52, 14, 12 and 7 percent of the fish sampled, respectively.

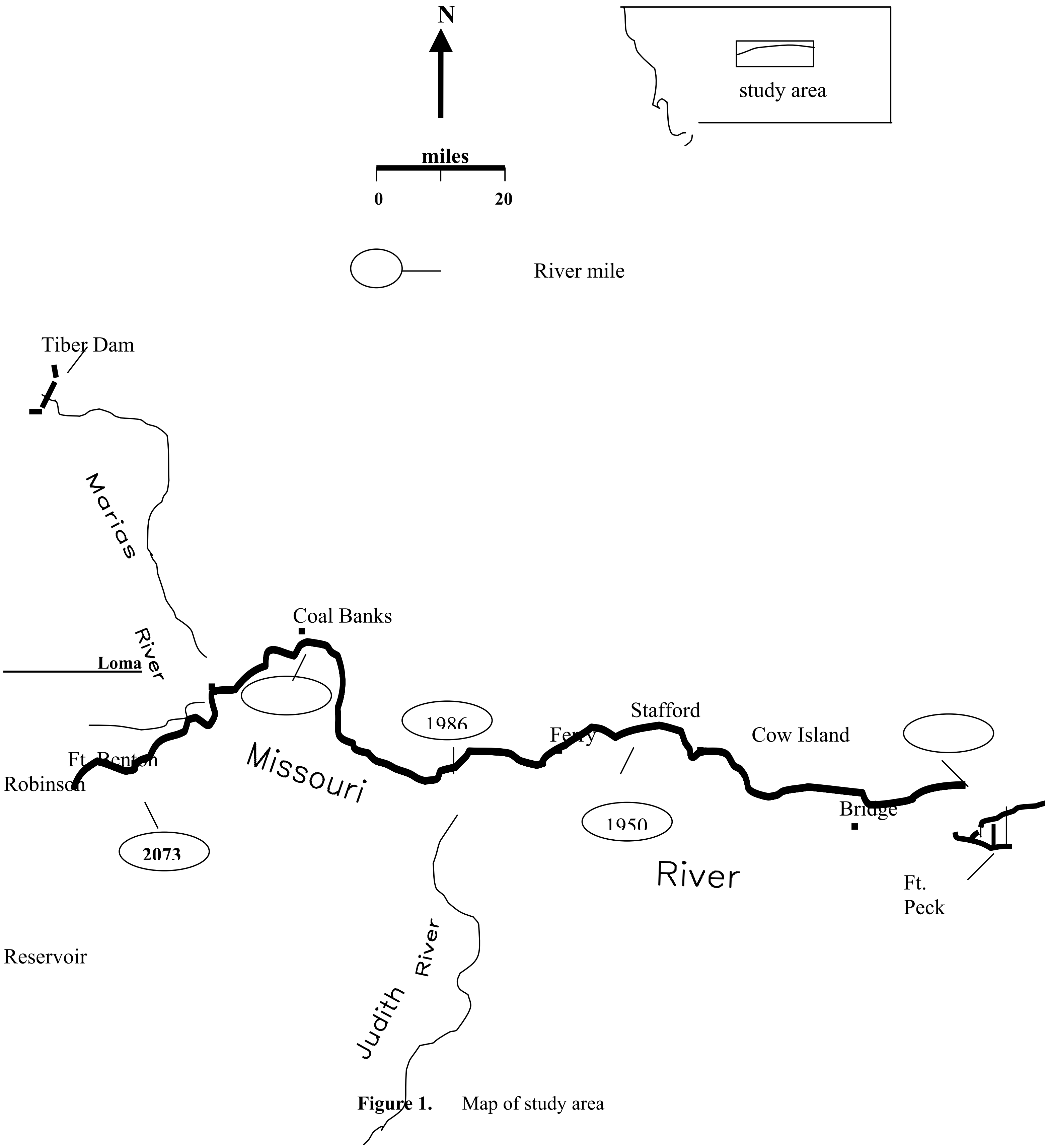


Figure 1. Map of study area

Benthic trawling:

The main purpose for trawling was to evaluate pallid and shovelnose sturgeon spawning success. A total of 627 fish, representing 14 species, were sampled while trawling during August in the lowest section of the study area (Table 4). The average physical conditions measured for the 125 tows were: Column water velocity = 2.1fps (1.3-2.8); Depth = 6.1ft (3-18); Channel location/macro-habitat = 62% channel cross-over area (CHXO), 18% inside bend area (ISB), 14% outside bend area (OSB), 3% side channel-connected (SCC), and 1% at tributary mouth (TRM). Most of the trawling occurred in the lower 36 miles of the study area between RM-1921 and RM-1885 where it is thought most of the age-0 SNS usually reside. Age-0 channel catfish were by far the most abundant species sampled comprising 42% of the total catch. Only 2 age-0 SNS were sampled this year compared to three in 2000 (Gardner 2001). The first year of intensive trawling (1995), a total of 28 age-0 SNS were sampled in about 100 tows (Gardner 1996) indicating this method was effective at sampling age-0 SNS when they are more numerous. Based on the low catches of age-0 SNS this year and previous years, it appears there has been poor SNS spawning success at least during the past two years.

Table 1. A list of hatchery-reared pallid sturgeon recaptured in the Upper Missouri River, MT, 2001-02.

PIT Number	Color	Recap date	Recap Rivermile	Release River mile	Recap Meth.	FL (in)	TL (lb)
414D3F414A	RED	9/26/01	1917.1	1984.3	Tram	19.0	0.80
411D-series	ORA	9/27/01	1907.0	UNK	Tram	17.3	0.51
411D291301	YEL	9/25/01	1920.9	UNK	Tram	15.9	0.45
414D62056B	GRE	9/27/01	1907.2	1920.6	Tram	18.5	0.78
411D273F62	YEL	10/30/01	1907.2	UNK	Tram	17.0	0.58
41095F113E	YEL	10/30/01	1907.2	1920.6	Tram	17.7	0.62
411D124A3C	GRE	10/31/01	1915.5	UNK	Tram	15.5	0.44
132338770A	ORA	6/14/02	1917.3	UNK	Tram	15.5	0.70

Table 2. Average catch rates (no./drift) of fish sampled while drifting trammel nets in the Upper Missouri River, MT, 2001 and 2002.

	Ft. Benton	Loma	White Rock	Stafford Fy.	Robinson	Total #
Bigmouth Buffalo			0.1			1
Brown trout		Tr				1
Blue sucker	0.2	0.5	0.5	0.3		34
Carp	0.5	0.2	0.1	0.2	0.2	40
Channel catfish		Tr	0.1	0.2	tr	7
Flathead chub			0.2	0.4	0.1	12
Freshwater drum	tr	Tr	0.1		tr	6
Goldeye	3.1	1.9	3.8	5.7	0.1	274
Longnose sucker	1.3	2.9	0.3	0.3	tr	141
Mountain whitefish	0.1	Tr				3
Northern pike	tr				tr	2
Pallid sturgeon					0.1	7
River carpsucker	0.6	0.1	1.2	0.6	0.3	67
Sauger	0.4	0.3	0.3	1.8	0.4	75
Shorthead redhorse	4.4	1.8	1.7	2.8	0.4	247
Shovelnose sturgeon	3.6	7.8	4.9	5.6	7.0	1039
Stonecat					tr	1
Smallmouth buffalo	0.3	0.2		0.2	tr	19
Walleye	tr		0.2	0.1	tr	8
White sucker	0.5	0.3			tr	22
Total # fish	321	565	241	216	663	2005
Total # drifts	21	35	18	12	76	162
Average depth (ft.)	6.0	5.4	6.1	6.8	4.9	5.8
Avg. velocity (fps)	2.8	2.7	2.4	2.3	2.3	2.5
Average distance (yd.)	315	297	217	340	275	288
Avg. duration (min.)	7.0	7.0	6.7	8.3	7.4	7.3

Table 3. Average catch rates (average number/tow) of fish sampled by trawling in the Middle Missouri River, MT, 2001.

	Loma	White Rock	Stafford Fy.	Robinson	Total #
Burbot y				tr	1
Carp y				tr	1
Channel catfish y		0.2	0.2	2.61	264
Emerald shiner y			0.1		1
Flathead chub	0.1	0.5	1.9	0.2	38
Hybognathus spp				tr	4
Longnose dace	1.8	3.3			40
Sand shiner	0.1		0.1		2
Sauger y				tr	2
Shorthead redhorse y				tr	1
Shovelnose sturgeon y				tr	2
Sicklefin chub				1.0	101
Stonecat	0.1	0.2	0.2	0.8	83
Sturgeon chub		0.3	0.4	09	87
# Tows	11	6	8	100	125
Avg. Depth (ft)	4.6	5.9	4.0	6.4	
Avg. Col. Velocity (fps)	2.4	2.2	2.2	2.1	
Macro-habitat type (%)					
CHXO	27	67	62	66	
ISB	45	16	12	16	
OSB	27	16	12	13	
SCC				4	
TRM			12		

Y = age-0 fish

Fall pallid sturgeon abundance standardized survey:

A total of 305 fish, representing 11 species, were sampled during the fall survey in the 16-mile Robinson Bridge trend area (Table 4). No adult pallid sturgeon were netted, however, four HRJ pallid sturgeon were sampled during the survey. Shovelnose sturgeon dominated the catch comprising 90% of the fish sampled. The highest SNS catch rate of 7.1 fish per drift occurred in the outside bend (OSB) macro-habitat type.

The standardized survey has been completed four times since 1996. Table 5 summarizes these survey results.

Table 4. Catch rates for fish trammel netted while conducting the fall pallid sturgeon standardized abundance survey, Upper Missouri River, September, 2001.

	------------ HABITAT	TYPE --------------				
	CHXO	ISB	OSB	Not Designated	Average CPUE	Total # fish
Carp	0.1		0.5	0.1	0.2	8
Flathead chub	0.1				*	2
Freshwater drum	0.1				*	2
Goldeye			0.1		*	1
Pallid sturgeon	0.1		0.1	0.1	0.1	4
River carpsucker	0.1		0.1	0.1	0.1	5
Sauger			0.1	0.2	0.1	4
Shorthead redhorse	0.1				*	1
Shovelnose sturgeon	5.1	4.3	7.1	5.3	5.5	274
Smallmouth buffalo	0.1	0.3		0.1	0.1	3
Stonecat	0.1				*	1
Total fish	108	18	81	98	--	305
Total drifts	19	4	10	17		
Average depth (ft.)	4.3	5.2	5.1	4.5		
Avg. velocity (fps)	2.5	2.3	2.3	--		
Average distance (yd.)	309	311	288	218		
Avg. duration (min.)	7.0	7.0	7.0	7.6		

Table 5. Sampling statistics recorded for the pallid sturgeon standardized sampling program in the Upper Missouri River, 1996-2001.

	1996	1997	1999	2000	2001
No. pallids sampled	3	1	1	3	4
Avg. Wt. (lb)	38.0	40.6	0.33	0.61	0.60
No. pallids/drift	0.06	0.02	0.02	0.06	0.08
No. shovelnose sampled	225	131	153	392	274
Avg. Wt. (lb)	3.15	3.17	3.30	3.42	3.4
Avg. No. shovelnose/drift	4.5	2.6	3.1	7.8	5.5
Average drift duration (min)	6.3	6.5	6.7	7.1	7.2
Average drift distance (yd)	239	294	239	222	2.81
Average depth @ drift site (ft)	7.1	8.3	7.1	6.0	4.7

Pallid sturgeon sightings, July1, 2001 to June 30, 2002:

Angler reports of pallid sturgeon sightings were recorded by FWP Region-6 seasonal paddlefish creel clerks, FWP game wardens and the pallid sturgeon crew. All sighting reports were scrutinized for identification and accuracy because of the taxonomic similarities between pallid and the commonly caught shovelnose sturgeon. Only pallid sturgeon sightings that included observations of colored elastomere marks on the ventral rostrum, presence of a transmitter, actual measurements of inner and outer barbel lengths (OBL $\geq$ 2X IBL), body length measurements (TL > 48 inches) or weight (>16 lbs.) were accepted as valid sightings.

Angler reports:

Number caught while snagging for paddlefish = not available
Number caught while bait fishing = not available

Pallid crew sampling:

Number caught in 6x10 gillnets = 3 (adults)
Number caught in trammel nets = 6 (all HRJ)
Number caught by angling = 2 (1 HRJ and 1 adult)

Propagation assistance:

RPMA #1

Preserving a representation of the Upper Missouri River pallid sturgeon gene pool is an important goal for recovery. To that end, a pilot effort was initiated in 2000 to capture and streamside spawn adult pallid sturgeon, as well as test the feasibility of collecting sperm from wild male pallids in this area and ship the fresh milt to Garrison National Fish Hatchery (GNFH) for use in their pallid sturgeon propagation program. Results from the initial effort proved worthwhile, with one female and five adult males being captured and spawned in June, 2000. Similar tasks were incorporated into annual work plans for 2002.

Progeny from the pallids spawned in RPMA #1 were reared at the Bozeman Fish Technology Center for release back into RPMA #1. Additional progeny from these family groups were reared at Garrison Dam National Fish Hatchery for release into RPMA #2. Approximately 1,800 of the 2001 year-class pallid sturgeon, raised at the Bozeman Fish Technology Center and representing five family groups, were released into RPMA #1 during July 2002. Approximately 1,627 RPMA #1 pallids that were reared at Garrison NFH were released into RPMA #2 in August 2002.

River flow conditions during June, 2002 were more normal compared to the previous three years, with discharges ranging from 8,330 to 19,400 cfs during June. However, these normal higher flows made netting for adult pallid sturgeon considerably more difficult than it had been during previous years.

One female pallid and two adult males were captured in RPMA #1 during June, 2002. They were examined for spawning readiness upon capture. A list the pallid sturgeon captured and their sizes and tag numbers are presented in Table 7. All were sexually mature, and the one female and one male were held in a 16-foot diameter tank for staging. Additionally, sperm samples from all male pallid sturgeon were cryopreserved to insure preservation of the Upper Missouri River population gene pool. Unfortunately the female pallid died during ovulation and only a few eggs were successfully fertilized. These eggs were reared at Garrison National Fish Hatchery and later developed into about 12 fingerlings, and were transferred to Gavins Point National Fish Hatchery and incorporated in the captive broodstock program. In addition to spawning pallid sturgeon, six SNS were spawned, producing several thousand eggs for experimental purposes at the USFWS Bozeman Fish Tech Center.

Table 7. A list of pallid sturgeon sampled during spring 2002, Upper Missouri River, MT.

PIT #	DATE	FL (in.)	WT (lb.)	Rivermile	Sex	Recap
7F7D303232*	May 17	51.5	32.0	1938	Unk	Yes
132319571A	June 11	59.0	48.0	1916.3	F	No
7F7D461025	June 11	51.0	30.0	1915.9	M	Yes

* This fish was not used in the propagation effort and caught earlier in the year

RPMA #2

The Upper Basin Pallid Sturgeon Recovery Workgroup requested that Miles City State Fish Hatchery propagate sturgeon from RPMA #2 for use in the recovery program. Towards that end, two adult females and two adult males, all captured at the Yellowstone-Missouri River confluence, were spawned at Miles City, and the progeny were raised at the hatchery. Four family groups were raised at the hatchery during 2001-2002. Additional progeny from these crosses were reared at Garrison Dam National Fish Hatchery as back-up. Surplus progeny were also provided to Neosho Fish Hatchery for use in recovery efforts lower in the basin. In August, 2002, a total of 1,277 tagged, 2001 year-class juvenile sturgeon from Miles City were released at five different locations in the Missouri and Yellowstone Rivers.

Missouri River Sturgeon Irido Virus assistance:

The recently discovered MRSIV could be a serious threat to the wild sturgeon populations in the Missouri River. It is unknown where the virus originated, although most investigators suspect it may exist in the wild. Because of the uncertainty of the virus origin, the viruses virulence and concern for wild sturgeon populations in Montana, the FWP suspended all pallid sturgeon stocking (from outside sources) in RPMA #1 until more information is available. Therefore, it is important to know if the MRSIV exists in the wild. The USFWS Fish Health Lab, Bozeman, MT, initiated MRSIV evaluations of wild sturgeon in 1999. Tissue samples were collected from 50 shovelnose and 2 pallid sturgeon from the Upper Missouri River, during 2002. These samples were fixed in a preservative and sent to the lab for histological and PCR analyses.

RECOMMENDATIONS

1. Continue with the intensive drift netting for HRJ pallid sturgeon. The success of the 1998 pallid release remains unknown and recapturing these fish will give better information on acclimation, survival and desirable release locations. The pallid sturgeon radio telemetry study should be resumed for gathering more information on movements and habitat preferences of HRJ pallid sturgeon. Information on the success of the 2001 year-class HRJ pallid sturgeon is also needed.

2. The fall pallid sturgeon abundance survey should be continued on an annual basis as funding allows. The HRJ pallid sturgeon should be approaching a size where they are more effectively sampled and this effort will more accurately describe their abundance in the area.

3. The Upper Missouri River pallid sturgeon gene pool has not yet been preserved. Efforts to collect sperm from ripe males should continue as conditions allow. The fresh sperm should be either used during the current propagation year or reserved in cryopreservation.

4. Continue sampling for age-0 pallid and shovelnose sturgeon with the trawl. Trawling has provided a considerable amount of information on shovelnose spawning success and the distribution and abundance of several unique fish species such as the sicklefin and sturgeon chubs. A better habitat description and quantification of the river reach where the age-0 sturgeon are found is needed so that age-0 sturgeon rearing requirements can be determined.

5. Continue propagation efforts at Miles City Hatchery to ensure a source of fish for recovery stocking in RPMA #2.

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2002 Pallid Sturgeon Research and Recovery Efforts in the Upper Missouri River, Montana (RPMA #1)

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1. A total of 19 pallid sturgeon were captured in 2002 (5 adults (*comprised of 4 recaptures and 1 new fish*); 9 juvenile-1997 and 5 juvenile-2001) (Table 1).

2. Netted 1female and 2 male pallids for on-site propagation. The female died during the spawning process and consequently only a few eggs were successfully fertilized. Sperm from the one new male was cryopreserved and stored at Garrison National Fish Hatchery (GNFH).

3. Initiated the first phase of the juvenile pallid sturgeon ecology study by radio tagging 9 juvenile-1997 pallids, 4 juvenile-2001 pallids and 7 wild juvenile shovelnose sturgeon. We made approximately 70 relocations on these fish along with collecting macro and micro habitat measurements. Key habitat areas were identified for phase 2 work next year where pallid food availability and detailed habitat characteristics will be investigated. The study was transferred to MSU for continuation during the next 2 years. MSU analyzed this years data and will present information at present meeting.

4. This year we completed our 2nd pallid sturgeon release since the augmentation program began in 1998. On July 23-24 a total of 2,063 yearling pallids (2001 year-class) from 5 family lots were stocked at 4 sites in the study area: Loma (RM 2051) = 418; Coal Banks (RM 2031) = 375; Judith Landing (RM 1984) = 375; and Robinson Bridge (RM 1921) = 895 (*476 of this total were the research portion*). The hatchery pallids averaged 9.2 inches fork length and 0.11 lbs at stocking time. MTFWP film crew, along with Great Falls TV station were on hand to document the event. Additionally, the Lewistown News Argus reported on the augmentation program.

5. Completed our 6th pallid sturgeon baseline abundance survey. The purpose of the survey is to monitor changes in the pallid population using a standardized approach so comparisons can be made for evaluating treatments directed at improving the pallid sturgeon population. The sampling area is the same 16 miles of river where I believe most of the adult live. Our effort consists of drifting 50, 2" trammel nets in a prescribed manner at randomly selected sites during late-September. This effort in 20002 captured a total of 4 pallids (*1 hatchery age-1, 2 hatchery age-5, and 1 wild adult*) (Table 2).

6. The main interest of the pallid work in the study area has been directed at evaluation of the release of 750 juvenile pallids, now 5 years old (PLS-97). What habitat conditions do they prefer, are they surviving and recruiting into the population, what are the best strategies for stocking pallids in the study area.

    - Have the PLS-97 been recruited into the population yet, after 4 years at-large in the wild? Probably not yet based on what I believe to be 3 years of poor growth rates (Table 3). At age-5 the PLS-97 are more the size of an age-3 shovelnose, however, this year it appears that the average forklength increase has improved. Comparisons with pallids raised completely in the hatchery and the released ones will show the same trend (i.e. that the 1997 year-class pallids are growing poorly).

- The survival of the PLS-97 appears to be good considering the fact that only 750 were initially stocked. During 2001 we captured 9 PLS-97; 3 by netting and 6 by hook/line. Additionally, Mike Ruggles (FWP) netted and released 2 PLS-97 in upper Ft. Peck Reservoir near the UL Bend, apparently related to an unusual summer flashflood in the Missouri River. Thus far we have recaptured a total of 31 PLS-97 since August 1998.

- Stocking strategies continued to be evaluated. We released the PLS-97 at a variety of places to evaluate what location is best for survival. This year only 4 of the 9 PLS-97 had PIT tags for referencing stocking history; all were captured at Robinson Bridge. Two of the recaptured PLS-97 were initially stocked far upriver at Loma and the other 2 were released at Judith Landing 63 miles upriver. It was surprising that none were from the Robinson Bridge (local) stocking. Of the 31 captured PLS-97 we have tag records on 17 and their point of release is as follows: Loma=5; Judith Landing=6; and Robinson B.=6. 94% of the PLS-97 captures occurred near the lowest release site (Robinson) but the PLS-97 point-of-origin is fairly equally distributed among the 3 release sites. This information indicates that PLS-97 continue to drift downstream (*some eventually drift into the reservoir*). Also, the PLS-97 which were stocked at up river areas appear to be fairing well and therefore releasing PLS-97 in upriver areas should continue.

- Evaluation of our tagging system. We have been witnessing a very high rate of tagging loss of PIT tags. Following is a summary of tag loss by year:
    - 1998 screened 3 and all had PITs
    - 1999 screened 3 and all had PITs
    - 2000 screened 4 and 3 had PITs
    - 2001 screened 9 and 4 had PITs
    - 2002 screened 9 and 4 had PITs

It appears that tag loss is increasing as time-at-large increases. The elastomere tags are all holding very good and tag visability is excellent.

- This summer a total of 1000 hatchery-reared yearling shovelnose sturgeon (SNS-01) were released in the Robinson B area for experimental purposes. One test will be to see if SNS-01 growth in the wild will be poor like is the case for PLS-97. We know that wild born SNS grow well in the area so if SNS-01 grow poorly it might lead us to believe that we have a hatchery problem (i.e. behavior modification at the hatchery results in poor growth once the SNS-01 are released into the wild). A second purpose for the SNS-01 is to validate our sturgeon ageing technique with these known age fish. A third purpose will be to do a quantitative/qualitative chemical content analysis for mineral diet studies. Another purpose will be to use these fish for our radio telemetry studies.

- Several state species of special concern (SSC) were sampled in the study area this year. Totals of 110 sicklefin chub and 40 sturgeon chub were captured while trawling. **Additionally, 4 sturgeon chub were sampled in the lower Marias River; a first-time recording for this species in the Marias.** Other SSC sampled this year were paddlefish (~50), sauger (~2000), and blue sucker (~30).

Table 1. Effort by sampling method and number of pallid sturgeon captured in the Upper Missouri River Study Area, MT, during 2002.

	Effort	Adults	Juvenile-97	Juvenile-01	Total
Trammel net #2 -	118 drifts	2	3	1	6
Spawning nets -	123 drifts	2	0	0	2
Trawl -	93 tows	0	0	4	4
Hook & line -	10 days	1	6	0	7
		5	**9**	**5**	**19**

Table 2. Sampling statistics recorded for the pallid sturgeon standardized sampling program in the Upper Missouri River, Montana, 1996-2002.

	1996	1997	1999	2000	2001	2002
Pallid Strugeon:						
Number sampled	3	1	1	3	4	4
Avg. Wt. (lb)	38.0	40.6	0.33*	0.61*	0.60*	.90*
Number/drift	0.06	0.02	0.02	0.06	0.08	0.08
Shovelnose Sturgeon:						
Number sampled	225	131	153	392	274	128
Avg Wt. (lb)	3.15	3.17	3.30	3.42	3.40	3.70
Number/drift	4.5	2.6	3.1	7.8	5.5	2.6
Average drift duration (min)	6.3	6.5	6.7	7.1	7.2	7.0
Average drift distance (yd)	239	294	239	222	281	259
Average depth @ drift site (ft)	7.1	8.3	7.1	6.0	4.7	5.4

- Juveniles present in sample.

Table 3. Size comparison between hatchery-reared pallids stocked in the Upper Missouri River, MT, during 1998 with wild shovelnose sampled at the same location, 1998-2002.

	------ Average Fork-length (in.) at Age-class -----				
	1yr	**2yr**	**3yr**	**4yr**	**5yr**
Pallid juvenile-97 -	11.5	15.3	17.7	17.1	19.4
Number measured -	3	3	4	9	11
Shovelnose - wild -	10.9	18.3	21.8	23.2	
Number measured -	7	15	30	17	

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Population Abundance Estimation of

Wild Pallid Sturgeon in Recovery-priority Management Area #2 of the

Missouri and Yellowstone Rivers During 1991-2001

by

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Abstract

Estimation of fish population abundance is necessary for understanding basic changes in population abundance and composition, and often provides the information needed for making fisheries management decisions. One of the few remaining concentrations of pallid sturgeon *Scaphirhynchus albus* occurs in the Missouri River downstream from the Fort Peck Dam to the headwaters of Lake Sakakawea and the lower Yellowstone River. This area was deemed recovery-priority management area #2 (RPMA #2) in the Pallid Sturgeon Recovery Plan. Population abundance estimates of wild pallid sturgeon in RPMA #2 have not been calculated since 1995. I used a modified Schnabel multiple-census mark-recapture procedure to estimate the population abundance, with 95% confidence limits, of wild pallid sturgeon in RPMA #2 during 1994-2001. I also used linear regression to quantify the relationship between population abundance and time (years). My results show a decreasing trend in population abundance of wild pallid sturgeon in RPMA #2 during 1994-2001. The population abundance estimate for 2001 was 178 individuals, with upper and lower 95% confidence limits of 351 and 96, respectively. Furthermore, the rate of decline indicated from linear regression of population abundance and time (years) indicates that the population of wild pallid sturgeon in RPMA #2 will go extinct during the year 2016. Decision-makers should err on the side of caution and adopt the lower 95% confidence limit of 96 individuals calculated from 2001 data as the working population abundance estimate for wild pallid sturgeon in RPMA #2. Furthermore, aggressive measures should be taken to maximize recovery efforts in the next 10 years.

Introduction

Estimation of fish population abundance is necessary for understanding basic changes in population abundance and composition, and often provides the information needed for making fisheries management decisions (Everhart and Youngs 1981; Kohler and Hubert 1993). One of the few remaining concentrations of pallid sturgeon *Scaphirhynchus albus* occurs in recovery-priority management area #2 (RPMA #2; Braaten 2001). RPMA #2 encompasses the Missouri River downstream from the Fort Peck Dam to the headwaters of Lake Sakakawea and the lower Yellowstone River as outlined in the Pallid Sturgeon Recovery Plan (Dryer and Sandovol 1993). Krentz (1995) used the Schnabel method to estimate the population abundance of wild pallid sturgeon in RPMA #2 during 1991-1995, but did not account for mortality of marked pallid sturgeon between sampling periods (years) and did not consider the small recapture sample size when calculating 95% confidence intervals. Furthermore, population abundance estimates for wild pallid sturgeon in RPMA #2 during 1996-2001 have not been calculated. Therefore, I modified the Schnabel multiple-census mark-recapture procedure in order to meet the most assumptions possible, estimated the population abundance of wild pallid sturgeon in RPMA #2 during 1991-2001, and used linear regression to quantify the relationship between estimated population abundance and time (years).

Methods

The Schnabel mark-recapture method is the simplest of the multiple-census procedures commonly used to estimate population abundance (Kohler and Hubert 1993). Multiple-census procedures use two or more sample periods for marking fish, such as for pallid sturgeon in RPMA #2. Pallid sturgeon were collected from the population, marked with passive integrated-transponder tags, and released for a series of samples; the numbers of recaptures and unmarked pallid sturgeon collected in each sample were recorded. The Schnabel population estimation formula is as follows:

$$\hat{N} = \frac{\sum_{t=1}^{n} C_t M_t}{\sum_{t=1}^{n} R_t}$$

Where $\hat{N}$ is the estimated population abundance, *M* is the number of fish initially marked and released, *C* is the number of fish captured and examined for marks in the sampling period, *R* is the number of recaptured fish found in *C*, the subscript *t* refers to the individual sample period, and *n* is the number of sample periods. When I applied the Schnabel method to pallid sturgeon population abundance estimation, each year's worth of sampling was considered one sample period *t*.

In order to obtain valid population abundance estimates from the Schnabel method, the following assumptions must not be violated: (1) marked fish do not shed their marks prior to the recapture period; (2) marked fish are not overlooked in the recapture sample; (3) marked and unmarked fish have equal mortality rates between the marking and recapture sampling periods; (4) marked fish become randomly mixed with the unmarked members of the population; (5) marked and unmarked fish are equally vulnerable to capture during the recapture period; (6) there are no additions (immigration or recruitment) to the population during the study; and (7) no mortality occurs during the study. I considered assumptions 1-4 and 6 to be satisfied in this application. Assumption 5 may have been violated in this application, as assessment effort was not randomly distributed throughout RPMA #2 during 1991-2001, and therefore, marked and unmarked pallid sturgeon may not have been equally vulnerable to capture during the recapture period. Assumption 7 would undoubtedly have been violated, as mortality occurred during the study interval 1991-2001. To address this issue, I (1) applied a 10% natural mortality rate to the population of marked individuals every sampling period (each year), and (2) subtracted each marked individual that was known to die during assessments from the population of marked individuals. The 10% annual natural mortality rate of adult pallid sturgeon was an estimate decided upon by the Upper Basin Pallid Work Group, and was further validated when I calculated an annual natural mortality estimate of $M = 0.1032$ for adult lake sturgeon *Acipenser fulvescens* aged 27-39 in Lake Winnebago, Wisconsin during 1955-1967.

Kohler and Hubert (1993) suggest using the methods proposed by Ricker (1975) when calculating the 95% confidence limits on population abundance estimates, $\hat{N}$, when the number of recaptures in each sampling period are less than 25 and $\hat{N}$ is not likely to be normally distributed. Since the number of recaptures in every sampling period (every year) was less than 50, I entered the number of recaptures *R* from each year into column x of Appendix II in Ricker (1975), read off the upper and lower 95% confidence limits on *R*, and substituted them back into the original Schanbel equation to obtain the 95% confidence limits on $\hat{N}$ for each year. These 95% confidence limits on *R* are more correct than those calculated when assuming that $\hat{N}$ is normally distributed (Ricker 1975; Kohler and Hubert 1993).

The population abundance of wild pallid sturgeon in RPMA #2 should be a decreasing linear function of time due to natural mortality, as I assumed annual fishing mortality, *Z*, to be zero, and there has been no documented recruitment to the population for several years (Braaten 2001). I used linear regression to quantify the relationship between the estimated population size and time (years). The liner regression formula used was as follows:

$$P = \beta_1 * Y + \beta_0$$

Where P is the estimated population size, β_1 is the slope, Y is the year in which P was calculated, and β_0 is the intercept.

Results and Discussion

My population abundance estimates for wild pallid sturgeon in RPMA #2 during 1991-1995 were less than those calculated by Krentz (1995) because I applied a natural mortality rate $M = 0.10$ to the population of marked individuals annually, while Krentz assumed no mortality on the marked population during 1991-1995 (Figure 1). While the population abundance estimates for wild pallid sturgeon in RPMA #2 during 1991-2001 do not appear to differ statistically across years (Table 1; Figure 2), there is a decreasing trend in population size (Figure 3). The 95% confidence limits around the 2001 population estimate, $\hat{N} = 178$, yields that there may have been as many as 351 or as few as 96 wild pallid sturgeon in RPMA #2 during 2001 (Table 1).

The small sample size in each year creates a great deal of variability around the population estimate, $\hat{N}$, resulting in large 95% confidence intervals. When dealing with a species as endangered as the pallid sturgeon, decision-makers should err on the side of caution and adopt the lower 95% confidence limit of 96 individuals calculated from 2001 data as the working population estimate for wild pallid sturgeon in RPMA #2.

Linear regression of estimated population size and time (years) resulted in the following:

$$P = -10.5274097 * \mathrm{Y} + 21226.0651$$

Where P is the estimated population abundance, -10.5274097 is the slope, Y is the year, and 21226.0651 is the intercept (Table 2). By substituting 0 in for the population size P and solving the equation for year Y, we can see that wild pallid sturgeon in RPMA #2 will go extinct during the year 2016. The population of wild pallid sturgeon in RPMA #2 may go extinct before 2016, however, if individuals reach an old-age threshold prior to the year 2016, or if fishing mortality, *Z*, is acting on the population. This is a strong reminder that the window of opportunity for recovering wild pallid sturgeon in RPMA #2 is closing rapidly. Aggressive measures should be taken to maximize recovery efforts during the next 10 years.

Acknowledgments

I must acknowledge Steve Krentz, United States Fish and Wildlife Service (USFWS), for providing a portion of the data utilized in this exercise, and all of the USFWS and Montana Department of Fish, Wildlife & Parks employees who collected the data utilized in this exercise.

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Table 1. Population abundance estimates of pallid sturgeon in RPMA #2 during 1991-2001 obtained from a modified Schnabel multiple-census mark-recapture procedure. Lower and upper 95% confidence limits are given.

Year	Lower 95% CI	N	Upper 95% CI
1991	27	255	2550
1992	67	304	1735
1993	84	249	782
1994	101	205	397
1995	108	217	436
1996	106	208	419
1997	100	186	357
1998	99	188	370
1999	96	180	353
2000	96	177	347
2001	96	178	351

Table 2. Output from linear regression of estimated population abundance and time (years).

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.865863184
R Square	0.749719054
Adjusted R Square	0.72191006
Standard Error	21.26479657
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	12190.89906	12190.89906	26.95958921	0.000569921
Residual	9	4069.724158	452.1915731		
Total	10	16260.62322			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	21226.0651	4046.932603	5.244976178	0.000531234	12071.26054	30380.86965	12071.26054	30380.86965
X Variable 1	-10.5274097	2.0275188	-5.192262437	0.000569921	-15.11397937	-5.940840033	-15.11397937	-5.940840033

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*	*Standard Residuals*
1	265.9923759	-10.99237591	-0.54489031
2	255.4649662	48.13753379	2.386169825
3	244.9375565	3.745079859	0.185643008
4	234.4101468	-29.8382593	-1.479077725
5	223.8827371	-6.802093598	-0.337178688
6	213.3553274	-5.284362688	-0.26194501
7	202.8279177	-16.76582875	-0.831079441
8	192.300508	-4.134516657	-0.204947327
9	181.7730983	-1.977955173	-0.09804692
10	171.2456886	6.250281587	0.309825455
11	160.7182789	17.66249684	0.875527134

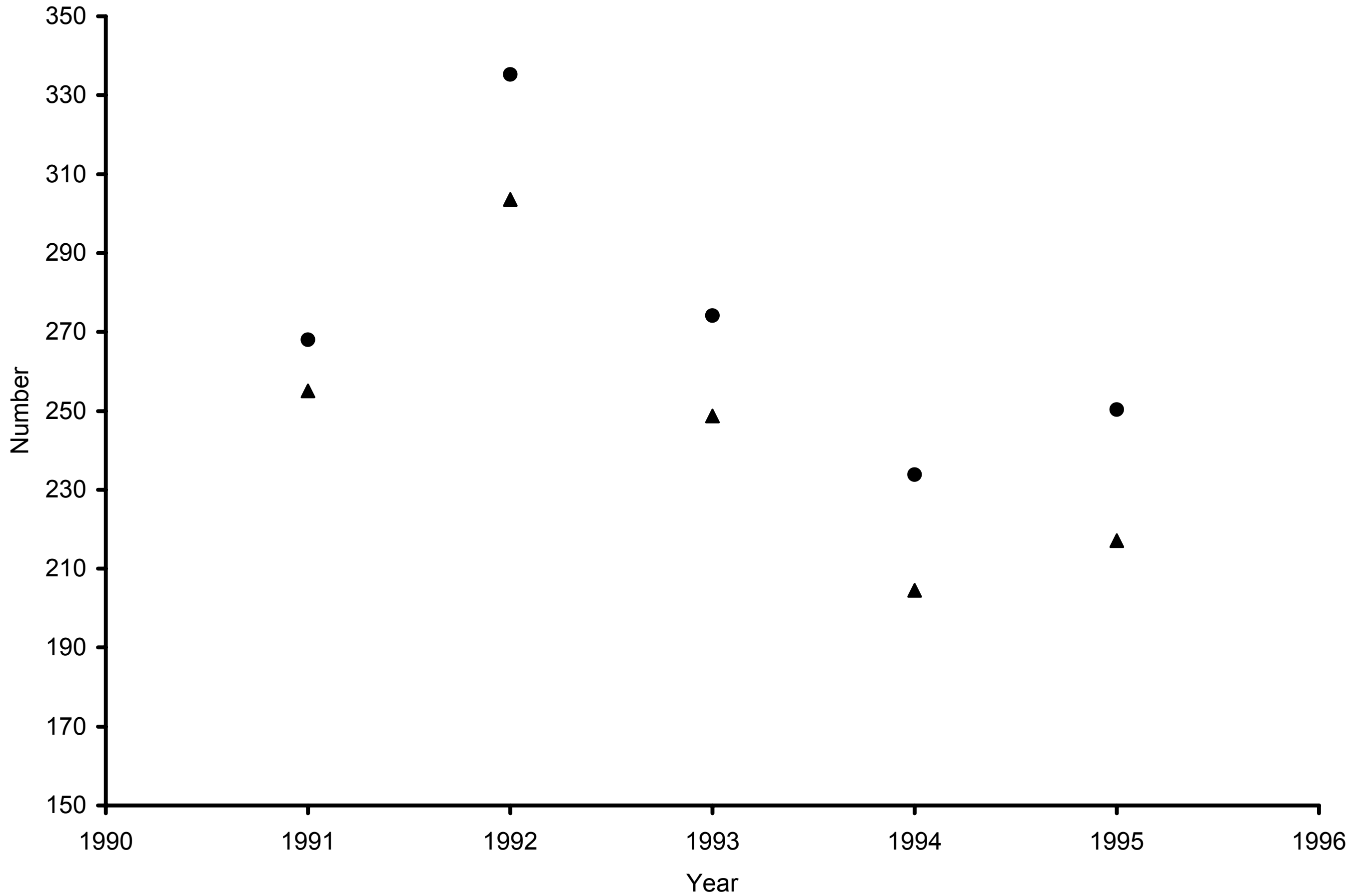

Figure 1. Population abundance estimates for wild pallid sturgeon in RPMA #2 during 1991-1995. Krentz (1995) calculated the population abundance estimates denoted by the circles, while my estimates are denoted by triangles.

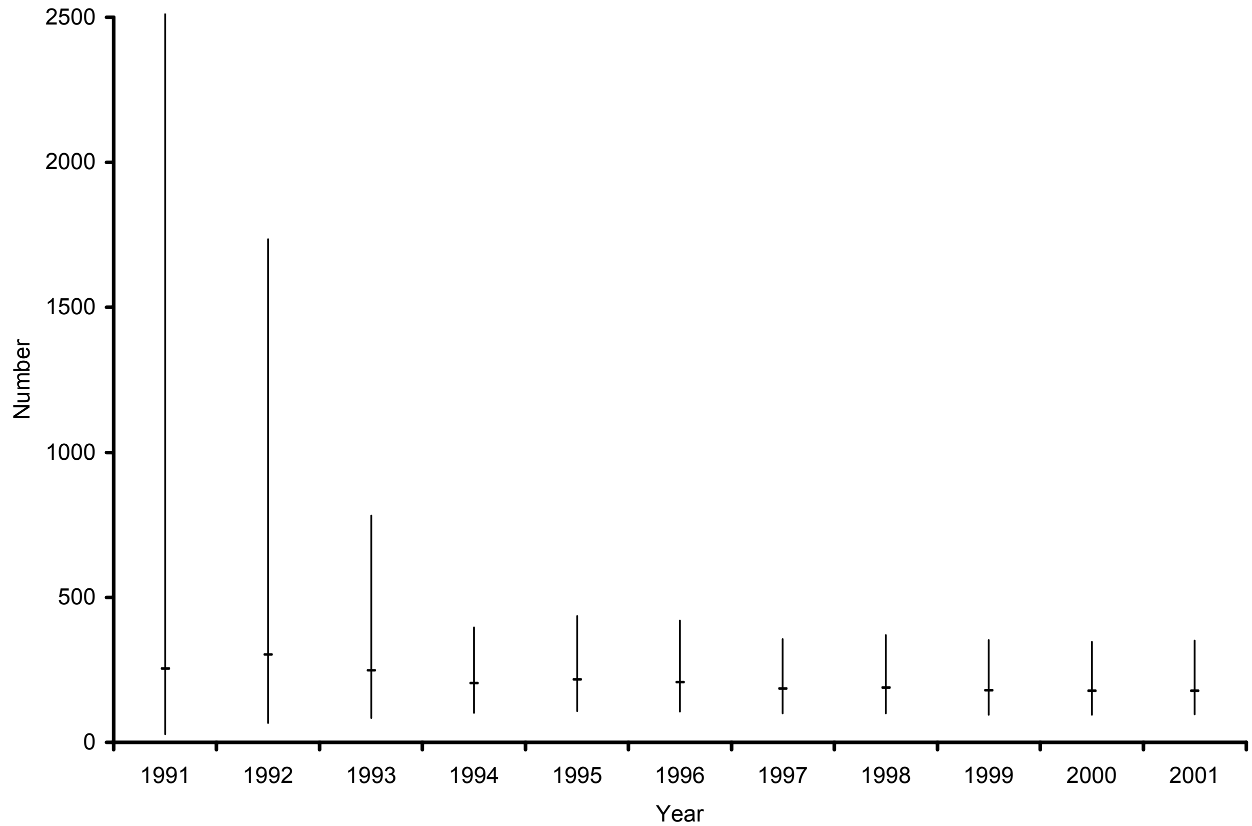

Figure 2. Population abundance estimates for pallid sturgeon in RPMA #2 during 1991-2001. Ninety-five percent confidence limits are given.

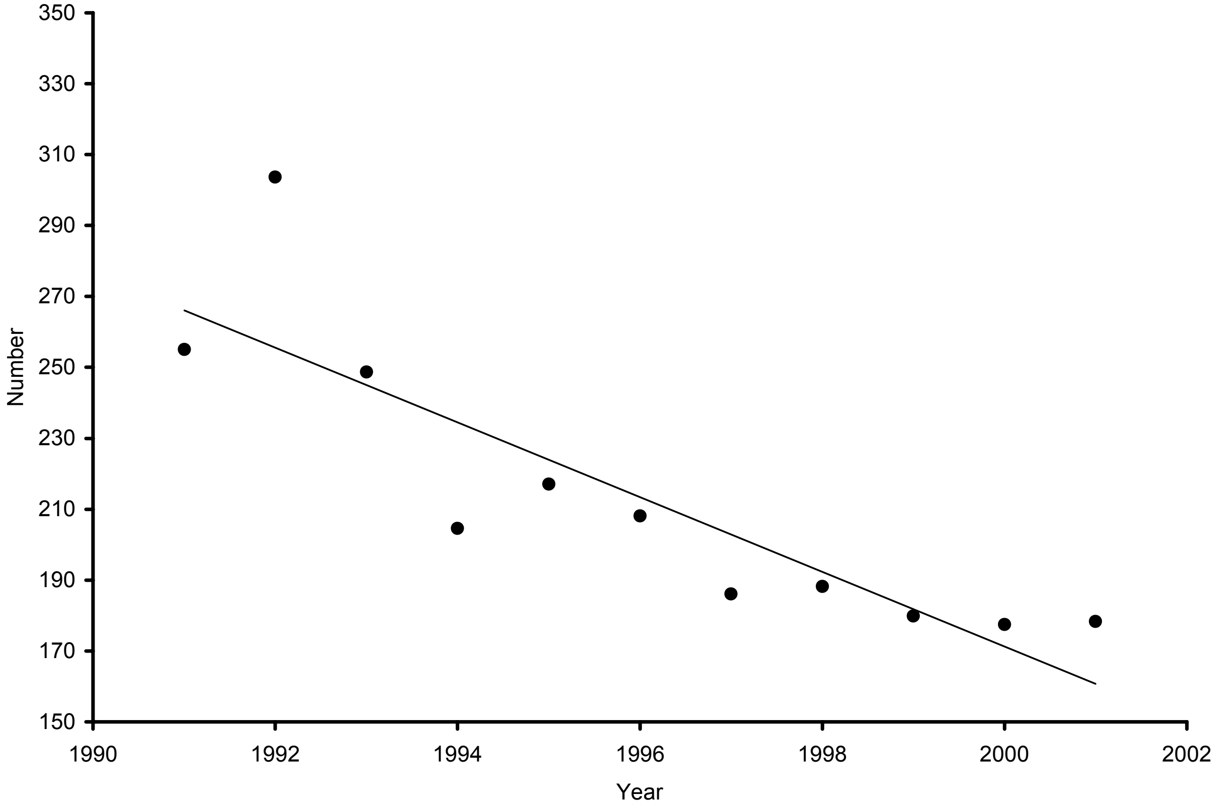

Figure 3. Population abundance estimates for pallid sturgeon in RPMA #2 during 1991-2001. A regression line of the population estimates and time (years) is given.

Fort Peck Reservoir Fish Inventory and pallid sturgeon.
Mike Ruggles, MTFWP Biologist

Annually, fish sampling occurs on Fort Peck with trap nets, gill nets and seines. On August 13, 2002, two pallid sturgeon were captured. Both were caught in the Upper Missouri Arm of the reservoir, 1 near Lost Creek at GPS coordinates 47.33.04, 107.45.38 (percent seconds) the other was up reservoir near Squaw Creek at GPS coordinates 47.32.24, 107.50.07 but on the opposite bank. A rough review of a reservoir map with the old river channel marked, showed both nets were set in or very near the old channel. The channel likely provided depth more suitable for our sampling than other areas at the time, as old river bed channel sites are not selectively sought during reservoir sampling.

The water was much more turbid than the water at Fourchette. Floating woody debris was in the main channel during sampling although there was no visibly apparent water current at the sites. A PIT tag reader isn't readily available during reservoir sampling. Documentation of pallid sturgeon is extremely rare in the reservoir. Shovelnose are uncommonly found during lake wide netting but have been documented in nets from the Upper Missouri Arm all the way to Nelson Creek in the Upper Dry Arm of Fort Peck Reservoir. Brett Bowersox of the University of Idaho sampled this area intensively for juvenile paddlefish in 2002 and may have some water chemistry measurements for this time period.

The Lost Creek pallid had two orange elastomer marks on the head. The pallid measured 19.6 inches (fork length) and 0.8 lbs. and was captured in water between 8 and 21 feet deep. The pallid was captured with 6 walleye, 9 carp, 11 drum, 8 white crappie, 2 black crappie, 9 goldeye, 2 river carpsuckers, 1 cisco, 4 channel catfish, and 3 sauger. The net fished from 1449 hrs on the 12th to 0900 hrs on the 13th of August. The pallid was released and appeared to be in excellent condition.

The Squaw Creek pallid had two blue elastomer marks on the head. The pallid measured 21.6 inches (fork length) and 1.2 lbs. and was captured in water between 12 and 15 feet deep. The pallid was captured with 6 shovelnose sturgeon. The ranges of lengths were from 27.4 inches to 20.3 inches and weights from 3.1 lbs to 0.9 lbs. The pallid was also captured with 10 drum, 2 black crappie, 1 carp, 1 channel catfish and 1 sauger. The net fished from 1400 hrs on the 12th to 0930 on the 13th of August. The pallid was released and appeared to be in excellent condition.

**Fort Peck Flow Modification Biological Data Collection Plan
Summary of 2002 Field Activities**

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Summary

The Fort Peck Flow Modification Biological Data Collection Plan (hereafter the Data Collection Plan) is a multi-year monitoring project designed to evaluate the influence of proposed flow and water temperature modifications from Fort Peck Dam on physical habitat and biological response of pallid sturgeon *Scaphirhynchus albus* and other native fishes. The Data Collection Plan is comprised of five monitoring components: 1) measuring water temperature and turbidity at several locations downstream from Fort Peck Dam, 2) examining movements by pallid sturgeon that inhabit areas immediately downstream from Fort Peck Dam, 3) examining flow- and temperature-related movements of paddlefish *Polyodon spathula*, blue suckers *Cycleptus elongatus*, and shovelnose sturgeon *Scaphirhynchus platorynchus*, 4) quantifying larval fish distribution and abundance, and 5) examining food habits of piscivorous fishes (sauger *Stizostedion canadense*, walleye *S. vitreum*, northern pike *Esox lucius*, shovelnose sturgeon, freshwater drum *Aplodinotus grunniens*, channel catfish *Ictalurus punctatus*, goldeye *Hiodon alosoides*, burbot *Lota lota*). The Data Collection Plan was initiated in 2001, and is supported by the U. S. Army Corps of Engineers. Major activities conducted during 2002, the second year of the project, area highlighted below.

Similar to 2001, spillway releases from Fort Peck Dam did not occur during 2002 due to insufficient precipitation and low water levels in the reservoir. Mean daily discharge between mid-May and mid-September 2002 was about 9,000-11,000 cfs in the Missouri River at Wolf Point, 9,000-12,000 cfs in the Missouri River at Culbertson, and 2,800-38,000 cfs in the Yellowstone River.

For Monitoring Component 1, water temperature was monitored between May and November at 17 locations during 2002 using continuous-recording (1-hr intervals) water temperature loggers. Turbidity was monitored at three locations in the Missouri River (Frazer Rapids, Poplar, Nohly) and one location in the lower Yellowstone River using continuous-recording turbidity loggers. Turbidity was also monitored at 2-4 day intervals concurrent with larval fish sampling (see below).

For Monitoring Component 2, no pallid sturgeon were found immediately downstream from Fort Peck Dam. SCUBA was conducted in February and March 2002.

Monitoring Component 3 was initiated in September and October 2001 when 18 blue suckers, 27 shovelnose sturgeon, and 19 paddlefish were implanted with combination acoustic, radio transmitters (CART). Shovelnose sturgeon and blue suckers were implanted near the mouth of the Milk River, Wolf Point, Culbertson, and at the Yellowstone River confluence. Paddlefish were tagged in the Erickson Island area. Tracking these fish began in mid-April 2002 and continued through November. Sixty days were spent on the Missouri and Yellowstone Rivers tracking a total of 3,464 river miles. Tracking efforts resulted in 579 relocations representing 62 individuals. Only two fish were not relocated, a shovelnose sturgeon which was rumored to have been harvested in the Wolf Point area and one blue sucker. The number of relocations was as follows: 159 blue suckers, 286 shovelnose sturgeon, and 134 paddlefish. Additionally, we had approximately 100 relocations of pallid sturgeon. These data were turned over to Wade King with the USFWS. We found the radio portion of the CART's to be most effective. We were able to manually track by boat at 30 mph, enabling us to cover nearly 300 miles of river in less than a week (i.e., from Fort Peck Dam to Williston, and from the Yellowstone River confluence up to Intake). Where there were holes greater than 25 feet deep, we would stop and use the hydrophone. Water depth, temperature, turbidity, and GPS coordinates were recorded at each relocation. During August and September, velocity, substrate and bedforms were also measured at relocation sites. To supplement our relocations, we also deployed five ground stations throughout the Missouri River. Ground stations were located near Culbertson (r.m. 1619), Brockton (r.m. 1651), Poplar (r.m. 1681), Wolf Point (r.m. 1717), Frazer (r.m. 1759) and up the Milk River (r.m. 3). These stations recorded 152 events of passing fish, including 25% of the pallid sturgeon implanted by the USFWS. One pallid sturgeon passed the Wolf Point station. Five of the nineteen paddlefish (26%) traveled at least up to Wolf Point, and two of these fish found their way into the Milk River.

During September 2002, an additional 21 shovelnose sturgeon, 21 blue suckers, and 3 paddlefish were implanted with CART tags. Five shovelnose sturgeon and three blue suckers were implanted near the mouth of the Milk River (r.m. 1761). Five shovelnose sturgeon, five blue suckers and three paddlefish were implanted in the Wolf Point area (r.m. 1698-1707). An additional five shovelnose sturgeon and eight blue suckers were implanted in the Culbertson area (r.m. 1614-1633). Finally, six shovelnose sturgeon and five blue suckers were implanted just upstream from the Yellowstone River confluence (r.m. 1582). All fish were captured with drifting trammel nets (232 drifts) with the exception of paddlefish that were captured in floating gill nets. Temperatures ranged from 10^{o}C – 16.3 ^{o}C. While sampling for telemetry fish, seven hatchery-reared juvenile pallid sturgeon were collected from three different year classes; three in the Wolf Point area, three in the Culbertson area, and one at the confluence. An adult pallid was captured in the Culbertson area (r.m. 1615).

Tracking in October and November was interesting as we relocated 110 and 109 individual fish respectively. There are approximately 144 fish with Lotek transmitters in the Missouri River. Wade King has 12 pallid sturgeon, Dennis Scarnecchia implanted 20 paddlefish, Kevin Kapucinski and Matt Baxter have 2 sauger with more being implanted this spring, and our crew has implanted 110 fish over the past two years.

For Monitoring Component 4, larval fish were sampled during 21 sampling events (5/21-5/22, 5/28-5/29, 5/31, 6/3-6/4, 6/6, 6/10-6/12, 6/13-6/14, 6/17-6/18, 6/20-6/21, 6/24-6/26, 6/27-6/28, 7/1-7/2, 7/3-7/5, 7/8-7/9, 7/11-7/12, 7/15-7/16, 7/18-7/19, 7/22-7/23, 7/25-7/26, 7/29-7/30, 8/1-8/2). A total of 1,970 larval fish samples were obtained at six sites (downstream from Fort

Peck Dam, 226 samples; in the spillway channel, 156 samples; Milk River, 370 samples; Wolf Point, 410 samples; Nohly, 414 samples; Yellowstone River, 394 samples). Of the 1200 samples processed to date, sturgeon larvae (e.g., *Scaphirhynchus* sp.) and paddlefish larvae have been tentatively identified in 16 samples from Wolf Point (7/15, 7/18, 7/25, 8/1), two samples from Nohly (7/11, 7/16), and two samples from the Yellowstone River (6/6). To complement the larval fish sampling program, the Data Collection Plan was extended to include a benthic sampling technique for young-of-the-year (YOY) sturgeon. Young-of-the-year sturgeon were sampled during four time periods (8/7-8/13, 8/22, 8/27-8/28, 9/4-9/5) using a benthic (beam) trawl. Sampling sites were located in Missouri River upstream from the Yellowstone River confluence, in the Missouri River-Yellowstone River confluence area, and in the Missouri River extending from the Yellowstone River confluence to just downstream from the Highway 85 Bridge in North Dakota. A total of 101 trawls were conducted, and 34 YOY sturgeon were sampled. However, 71% of the YOY sturgeon were sampled during the 9/4-9/5 sampling period primarily from the Highway 85 Bridge area (N = 20 individuals). Young-of-the-year sturgeon sampled on 9/4-9/5 averaged 21 mm (minimum = 17 mm, maximum = 25 mm).

For Monitoring Component 5, stomach contents from potential piscivores were obtained in July and August. Stomach contents were obtained from 100 saugers, 14 walleyes, 45 northern pike, 86 goldeye, 63 shovelnose sturgeon, 8 freshwater drum, 5 burbot, and 60 channel catfish.

Movements and Habitat Preferences of Adult Post Spawn Pallid Sturgeon

2002 Progress Report

March 17, 2003

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And

Ryan H. Wilson
Project Technician

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Missouri River FWMAO
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This report submitted to:

Cooperators

Bureau of Reclamation

Garrison Dam National Fish Hatchery

Montana Fish, Wildlife and Parks
Fort Peck Field Office

North Dakota Game and Fish Department

Upper Pallid Sturgeon Workgroup

US Army Corps of Engineers

US Geological Survey
Fort Peck Field Office

Western Area Power Administration

List of Figures

Introduction

This report summarizes the research and field activities conducted in April through October of the 2002 field season. The main goals of this study are to monitor post spawn migrational movements to help identify pallid sturgeon spawning areas, determine pallid sturgeon response to " Spring Test Flows " out of Fort Peck Dam to see if mimicking natural flows will expand pallid use and habitat into the Missouri River above the confluence of the Yellowstone River, and to evaluate reproductive stages of known post spawn females. We also hope telemetered pallid sturgeon will serve as an important tool for future broodstock capture by utilizing and netting possible aggregations in relation to telemetered fish. Netting additional fish and marking them with Passive Integrated Transponder (PIT) tags will also serve to help strengthen current population estimates.

Study Area

The pallid sturgeon study area (See Figure 1, for study area), for the most part, is a semi-confined stretch of approximately 290 river miles encompassing the Missouri River from Fort Peck Dam to the headwaters of Lake Sakakawea and from the Yellowstone River confluence (~ RM 1582.0) up the Yellowstone River to the Intake Diversion Dam, Intake, Montana.

As suggested in the Post Spawn Telemetry Study Plan, datalogging station locations had to be adjusted due to a variety of factors, but eventually all stations were placed in well-suited areas that met the criteria needed to work effectively. Our first station initially was placed up the mouth of the Yellowstone River, a few hundred yards adjacent to or above the confluence on the west riverbank below the high water line. Later in the summer, it was moved to the east bank on private property, due to low water conditions. The second station, which is identified as the Fort Union Station, is approximately 5 river miles up the Missouri River above the confluence, and as its name suggests, lies due east of Fort Union State Park on the north shore of the Missouri River on State-owned land. The third station was located approximately 11 miles down the Missouri River on the Erickson Island State Game Production Area and is located on the north shore of the river.

Two additional logging stations were funded for the 2002 field season by the Bureau of Reclamation (BOR) and the North Dakota Game and Fish Department (NDGFD), which brings the total of stations to five. The BOR station was positioned on Montana Dakota Utilities property outside of Sidney, Montana, (RM 30.1) on the Yellowstone River. The NDGFD funded station was placed downstream of the Ducks Unlimited Pumphouse (RM 1557) on the lower Missouri River. The addition of the two new stations benefited the project, helping to expand the study area into more manageable reaches and providing more movement data.

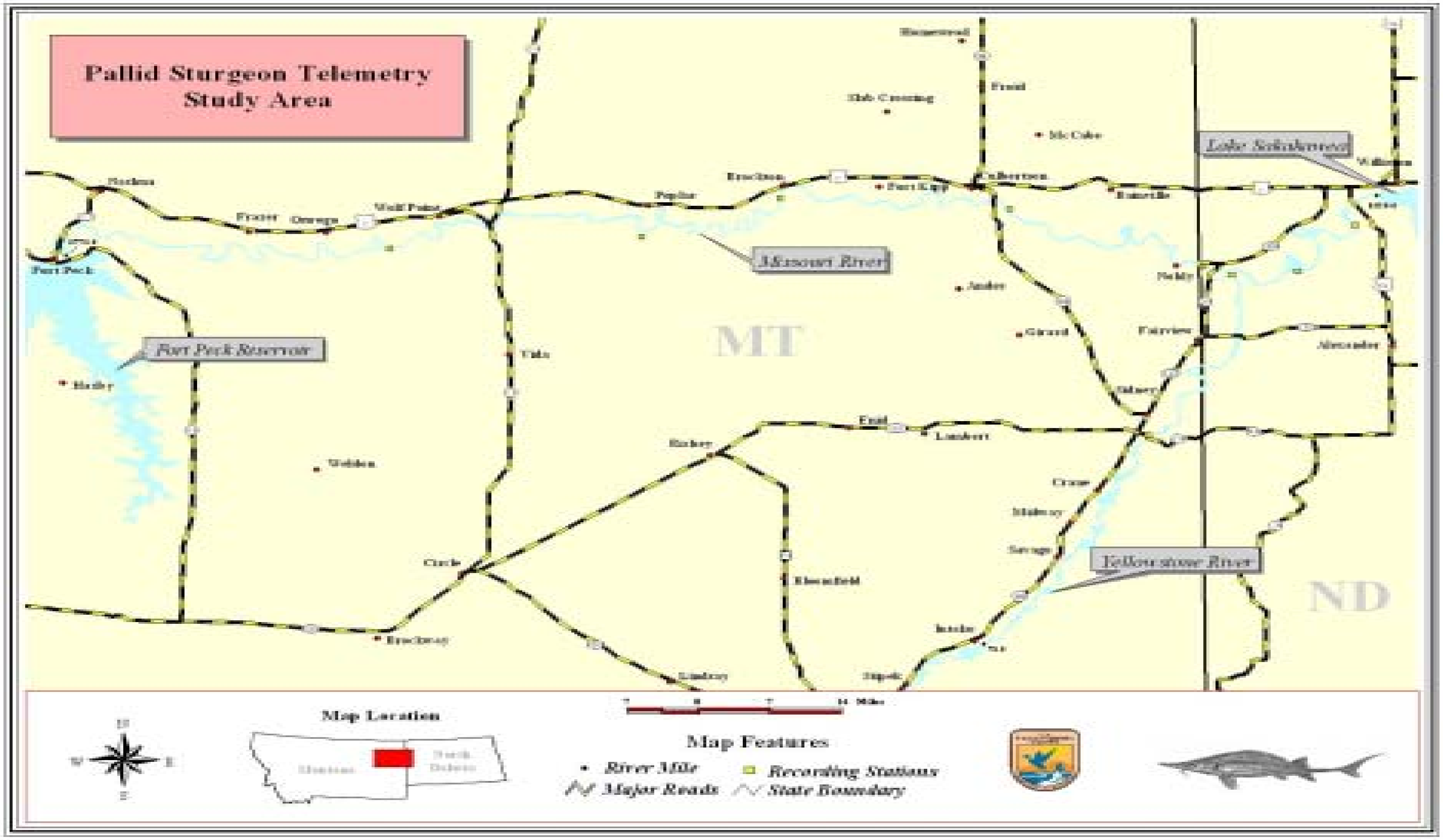

Figure 1: Map of study area

Methods

Pallid sturgeon telemetry tracking started in the second week of May 2002, and manual tracking resumed throughout the month and continued until the end of June. During the month of July, we started a less stringent tracking regime, only tracking every third week, which was continued through October, when fixed datalogging stations were taken out of the river.

Tracking methodology, as well as other methods, has been described in last year's progress report and the USFWS's draft proposal plan, so rather than describe them here, one can refer to the previous year's literature.

One addition utilized in this past field season's tracking, was the implementation of using a cell phone link to the Sidney fixed datalogging station. This system allowed us to download the station data from a hotel or office, with the aid of a computer. The remote system also allowed us to check settings and change them, call the station to see if it is still operating properly, and most importantly, check the data to determine if one of our study fish has moved into another study reach.

Due to the number of paddlefish on the 149.760 pallid frequency, the addition of two more cell phone links and three more W31 receivers will be utilized to ensure data can be downloaded before memory banks fill up and data is lost. This became a problem on a few different occasions in the 2002 tracking season and should be resolved with the upgraded receivers and technology.

No pallid sturgeon were tagged after the spring 2002 spawn, due to a number of mortalities of the broodstock adults in the hatchery. Although only one mortality (which possibly was the result of cumulative stress from spawning, as well as tagging,) has been associated with the telemetry project; surgically implanting telemetry tags was suspended for a year until the mortality issue in the hatchery could be addressed.

For further clarification of tables and figures listed in this report, fish spawned in the spring of 2000 were named starting with the letter "A," and fish spawned in the spring of 2001were given names with the letter "B." Because no fish were tagged in the spring of 2002, C will be skipped and fish spawned and tagged in 2003 will all be designated with names starting with "D."

Results and Discussion

During the 2002 spring broodstock capture, a male pallid sturgeon with rather suspicious scar tissue was netted. After referencing the pallid sturgeon database for passive integrated transponder (PIT) tag matches, it was conclusive this fish was a previous telemetry study fish. Aaron, fish # 38, had been tracked in the fall of 2000 when he was released back to the river and beginning in the spring of the 2001 field season, was unable to be located till present. His tag incision had healed perfectly and no signs of stress or infection were observed.

Consequently, we saw this happen at least two more times in the 2002 field season. Amber, fish # 62, lost her tag approximately at river mile (RM) 1558 above the Ducks Unlimited Pumphouse. In mid-April, she was observed crossing the Erickson Island Station and staging downstream below the Confluence Station for a brief period of time. She then was located by boat at RM 1567 in May. Somewhere after that time period, she shed her tag in about 7 feet of water adjacent to an island. We continued to pick up here tag throughout the summer at the same location without it ever moving. Attempts were made to net the fish on different occasions, but no movements were ever monitored. Water levels never reached shallow enough depths to attempt retrieval.

Al, fish # 22, also departed from our study this field season. This tag was apparently shed in the early spring of 2002. Montana, Fish, Wildlife and Parks crews' picked up his signal at Big Sky Bend (~RM 17), where it remained for the rest of the year. In late August, attempts to retrieve the tag were conducted. The tag was located in approximately 2 to 3 feet of water and maximum signal output was picked up on our receivers helping us isolate the tag within a couple foot radius, unfortunately after digging for a couple of hours, the tag could not be retrieved.

Bridget, fish # 10, has also been unable to be located since she was returned back to the river. The loss of this fish, as well as Amber, has definitely hurt one of the objectives of the study and has left us with only one female study fish.

Table 1: List of the class of 2000 remaining in the study, as of October 2002.

Name	Code	Sex	Pit tag #	Weight in Pounds	Weight in Kilograms	Fork Length in Inches	Fork Length in Millimeters
Art	18	M	1F4849755B	33	14982	51	1295
Annie	25	F	1F47715752	55	24970	62	1580
Andre	26	M	7F7B081579	32	14528	56	1444
Alex	34	M	115525534A	36	16344	55	1404
Arnie	44	M	2202236E31	61	27694	60	1542
Archie	46	M	1F4A33194B	45	20340	57	1468
Andrew	50	M	115713555A	28	12712	53	1352

Table: 2. List of the class of 2001 remaining in the study, as of October 2002.

Name	Code	Sex	Pit tag #	Weight in Pounds	Weight in Kilograms	Fork Length in Inches	Fork Length in Millimeters
Butch	2	M	1F4A27214F	50	22857	61	1541
Bart	14	M	115631222A	29	13257	52	1340
Bob	116	M	7F7D3C5708	30	13714	55	1405
Ben	144	M	1F4A111C6A	43	19657	55	1394

A primary objective of this study was to establish the time between spawns for adult pallid sturgeon and to learn more about the reproductive physiology of these native river fish. Past spawning records from a female sturgeon suggests they may spawn between 2 and 7 years, as well as physical evidence displayed by two, small pallid/pallid hybrid females at GDNFH. Once a female was identified with gravid eggs, it was hoped that tracking her would lead to pallid sturgeon spawning grounds and give us an idea on the stage periods between spawns.

Fish # 25 was located in the lower Missouri River on April 24th, and subsequent netting drifts were made to capture this female on two different days. Unfortunately, she was located in a deep trough along the shore and was unable to be captured. On two separate occasions (June 19-21 and June 30 to July 8th), she proceeded to migrate up the Missouri River to the USGS's Culbertson datalogging station (RM 1619). Unfortunately, we were unaware of her location and she eluded us until mid-August, when she was found in the lower Missouri River around RM 1556.5.

Upon relocation of the Annie on August 22 at RM 1664.7, Garrison Dam National Fish Hatchery Manager, Rob Holm, was contacted immediately and met us at the highway 85 boatramp 3 hours later. We then drift-netted for the female and captured her on the third drift, at which time we went to shore and prepared to tube her. Rob used a ¼-inch diameter, 30-inch section of clear, plastic tubing to perform the procedure.

Upon tubing the female, no small white eggs or black shriveled, larger eggs were found. Two subsequent attempts were made to extract eggs off the ovary, but no eggs were present. Annie was released and remained present in the lower Missouri throughout the rest of the summer and into the end of the tracking season. Although we can't be positive, due to the lack of any eggs present, two possible scenarios could exist. One, she spawned her eggs in the spring of 2002 and is in the process of regeneration; and, if this theory is true, she should have small, white eggs present on her ovaries in the spring of 2003. Two, if no sign of eggs are found on the ovary in the spring of 2003, it will be safe to assume that it will take a longer duration for her to attempt another spawn.

Diel movements were also recorded and compared for the 2002 fish by using data from individual fish passing fixed datalogging stations. The stations list the time the fish enters and leaves the range of station hydrophones. Times from boat relocations were not considered.

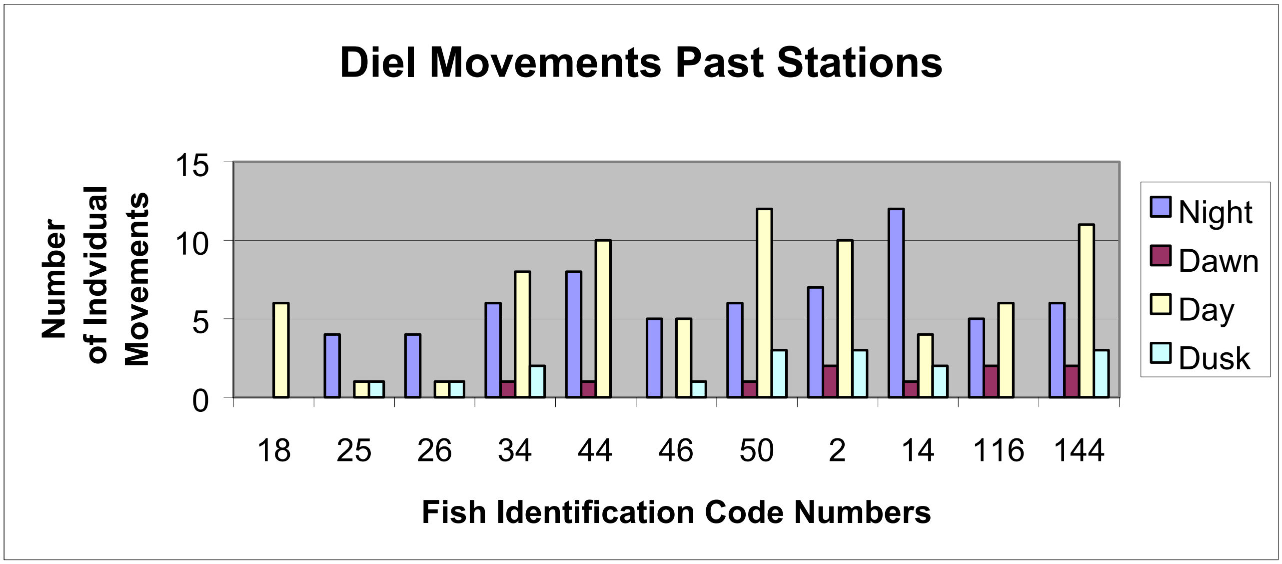

Table 3: Diel movements of the11fish remaining in study for the 2002 field season.
Night = 1 hour after sundown to 1 hour before sunrise.
Dawn = 1 hour before sunrise to 1 hour after sunrise.
Day = 1 hour after sunrise to 1 hour before sunset.
Dusk = 1 hour before sundown to 1 hour after sundown.

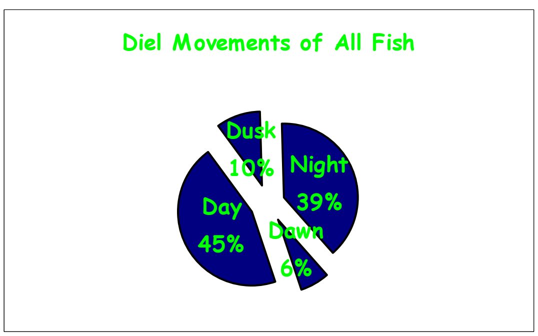

Figure 2: Diel movements for all fish in 2002.

Although diel movements differed significantly between some fish, there seems to be only a marginal difference between the higher percentages of daytime movements from the nighttime movements recorded.

A total of 331 observations were recorded in the 2002 field season, with 139 of them coming from boat relocations. A portion of the boat relocations came from Montana Fish, Wildlife and Park's fishery crews tracking paddlefish in the same confines of the river. This added information helped fill the gaps in data when fish sometimes slipped past stations and were not recorded.

With the addition of the USFWS's two stations and the deployment of the Montana based USGS stations on the upper Missouri River to Fort Peck Dam, fish movement was recorded both higher in terms of RM's traveled up in the upper Missouri and Yellowstone Rivers. Fish # 144 traveled up the Missouri River to the Wolf Point, Montana, Station (RM 1717), from May 20 to June 8 and ranged as low as RM 1555.4 in the lower Missouri in mid-July to the last boat relocation on November 8, 2002. From lower to upper river reaches, he spanned over 161 river miles in the Missouri and also made a couple of appearances 4 to 5 miles up the Yellowstone. In the Yellowstone River, a male pallid sturgeon was relocated 50 miles above the confluence, marking it as the highest a fish has been observed in that reach.

Although we saw greater distances traveled from a few individual pallids, overall fish movement seemed to decrease in 2002 compared to 2001. In 2001, only three fixed datalogging stations were active in the study and they recorded a total of 165 observations of fish passing them. For the 2002 field season, the USFWS deployed five stations and the USGS deployed at least five additional stations from Culbertson, MT, to Fort Peck Dam, Montana. In all, there were over three times the stations deployed and activated, and they accounted for 192 station observations, only 27 more than last year.

A large proportion of movement mimicked behavior from last year's observations. In April, May, and June, fish reacted to the rising and falling hydrographs daily; later in the summer to early fall, response was usually limited.

The study pallids are definitely exhibiting some unique behavior that has carried over from 2001 to 2002. Two males, Art (18) and Andre (26), have consecutively passed the Yellowstone Station and have spent almost the entire summer around or above Sidney, Montana. Andre passed the Yellowstone Station on May 19 in 2001 and on May 17 in 2002 to spend most of the summer above Sidney, and then returned in August and September. Art basically followed the same behavior and traveled up the Yellowstone on May 25 and also spent his summer ranging above the Highway 200, Fairview Bridge to about 10 miles above Sidney, MT.

For 2 consecutive years, Annie, the sole female left in the telemetry study has selected to stay in the Missouri River, this past year ranging from RM 1557 in the lower Missouri to RM 1619, at Culbertson, MT, on the upper Missouri. Although on both years she was recorded staging around the Yellowstone Station, she has never been relocated by boat up the Yellowstone River.

This was also the case for Butch, a male from the class of the 2001 spawners. He was captured four times in one week during the broodstock capture in mid-April at the confluence, and finally dropped down into the lower Missouri, where he stayed for the rest of the summer. This fish didn't seem to exhibit any urge to follow the hydrograph and spent most of the season between the Erickson Island and the Williston Stations. In fact, he never did migrate up to the confluence or show up on the Yellowstone Station. Although, I suspect some of his behavior may have stemmed from the stress induced with being caught four times in April, it's possible his home range may be that small considering all the movement he displayed within the small area.

As mentioned above, many of the telemetry study fish were either captured or monitored in the confluence area during the April broodstock capture. Besides Butch, Arnie was captured three times and three other fish were at least captured once. Radio- transmittered fish aided in the capture of non-tagged sturgeon on a couple different occasions, including a large female caught up the Yellowstone River adjacent to where Archie, fish # 46, was netted previously.

On three occasions during the field season, we relocated pallid sturgeon using slow, shallow side channels, which was interesting, considering we did not see this happen in 2001. In two of the cases, the side channel was shallow, with about 3 feet of water and we saw the pallids moving around continually, possibly feeding.

Plans for the 2003 field season include the same tracking schedule and protocol, hopefully with the addition of more study fish in the spring. Baseline data will continue to be taken to compare against fish movement associated with USACE proposed test flows slated for the future.

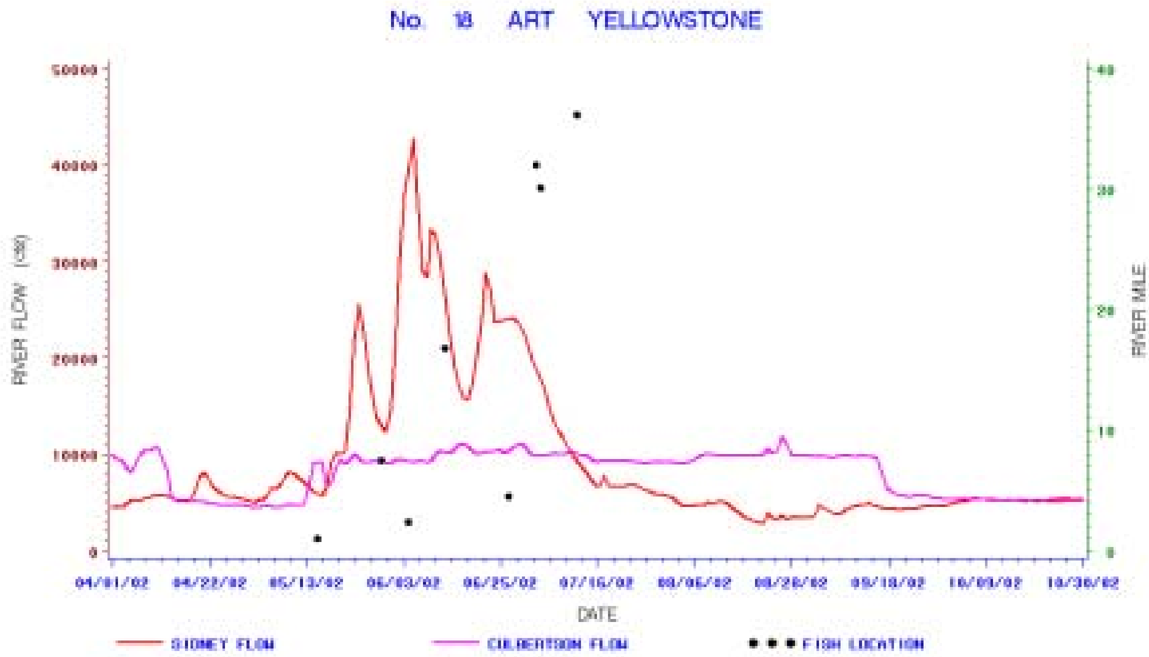

Figure 3: Relocations for Art, fish # 18, by river mile in the Yellowstone River plotted against flows from the Sidney and Culbertson gauging stations.

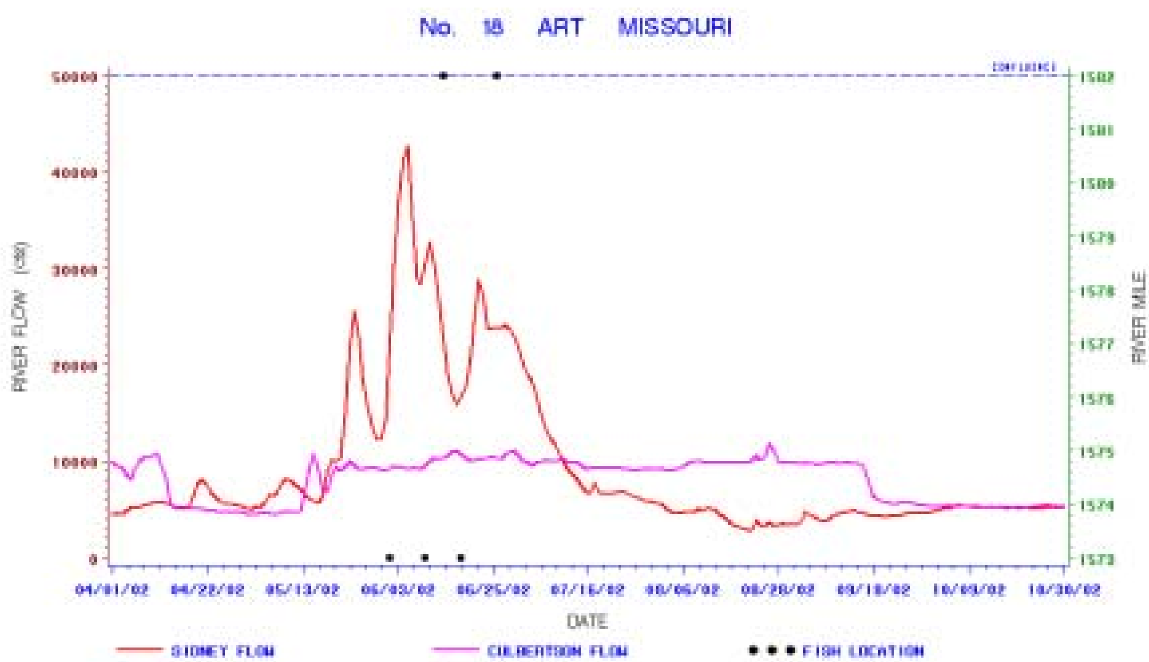

Figure 4: Relocations for Art, fish # 18, by river mile in the Missouri River plotted against flows from the Sidney and Culbertson gauging stations.

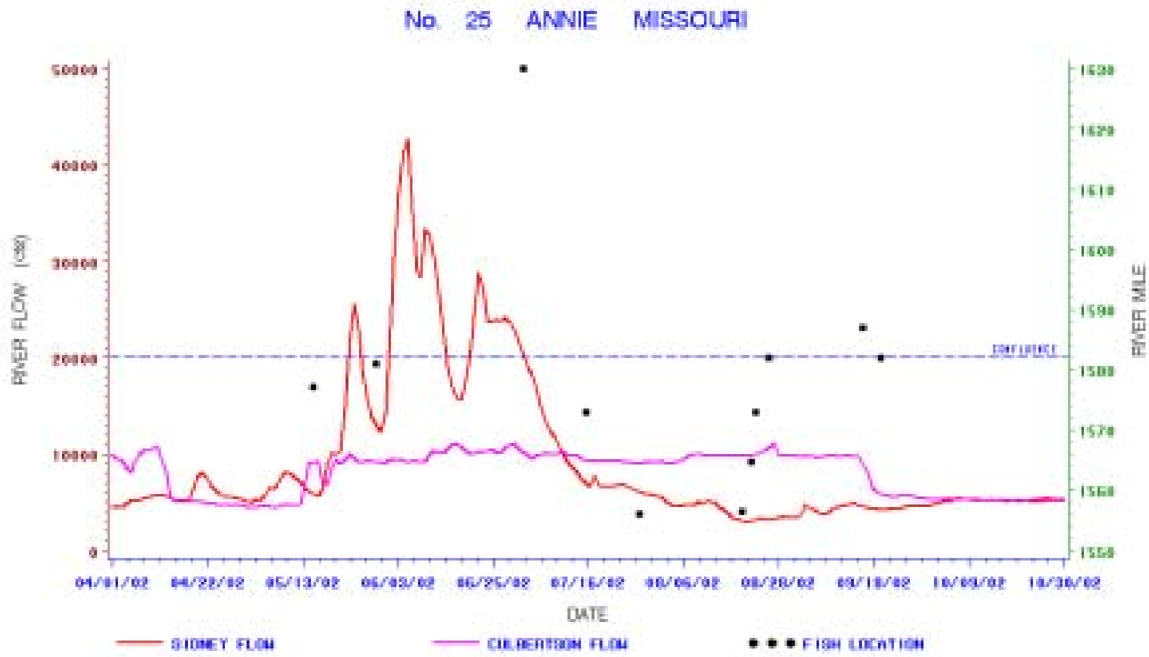

Figure 5: Relocations for Annie, fish # 25, by river mile in the Missouri River plotted against flows from the Sidney and Culbertson gauging stations.

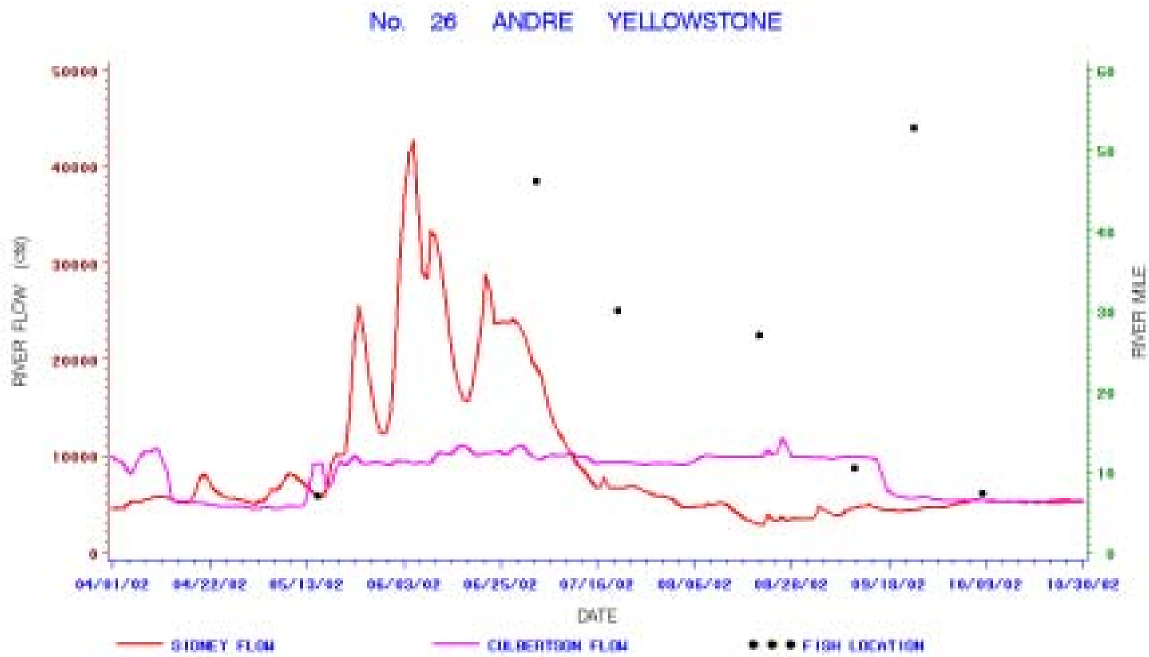

Figure 6: Relocations for Andre, fish # 26, by river mile in the Yellowstone River plotted against flows from the Sidney and Culbertson gauging stations.

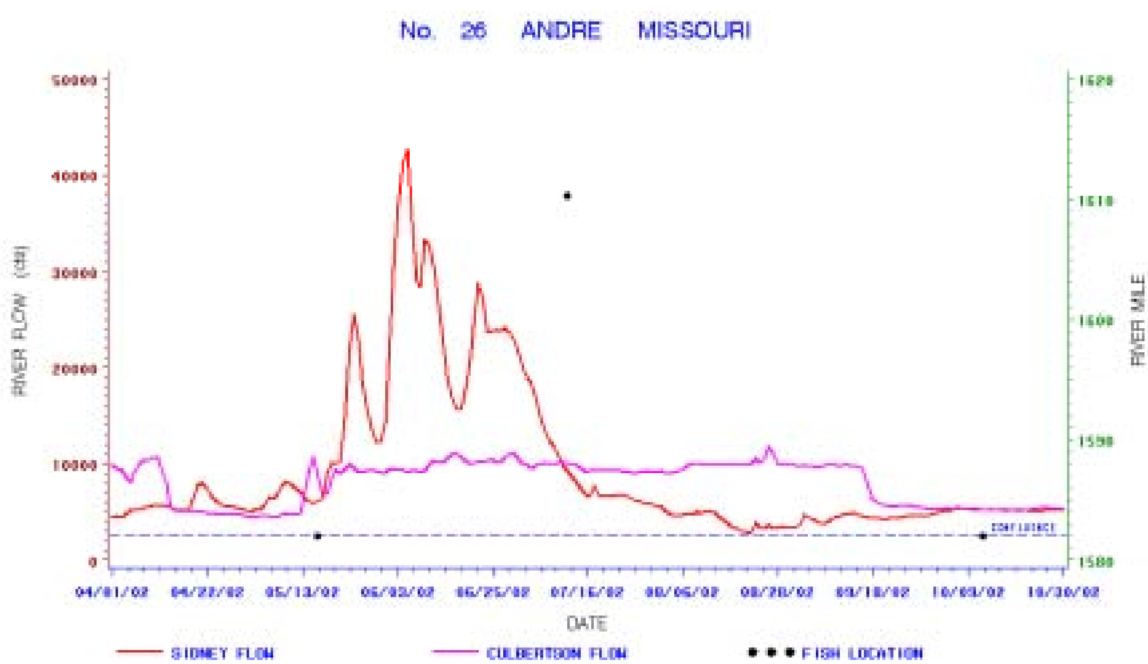

Figure 7: Relocations for Andre, fish # 26, by river mile in the Missouri River plotted against flows from the Sidney and Culbertson gauging stations.

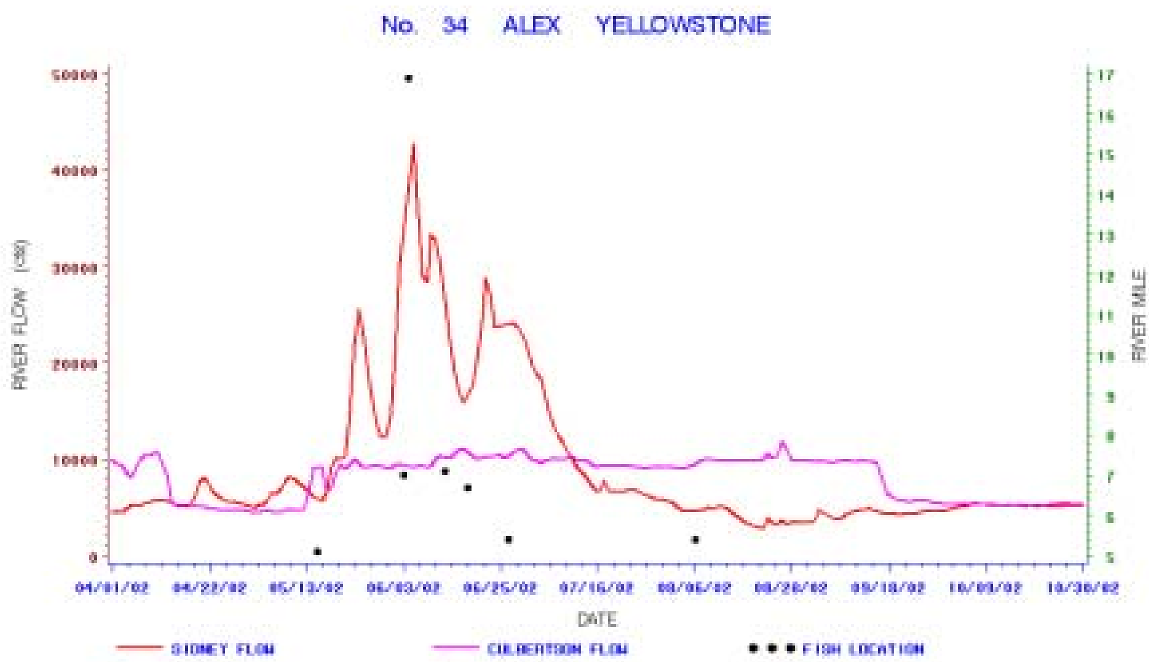

Figure 8: Relocations for Alex, fish # 34, by river mile in the Yellowstone River plotted against flows from the Sidney and Culbertson gauging stations.

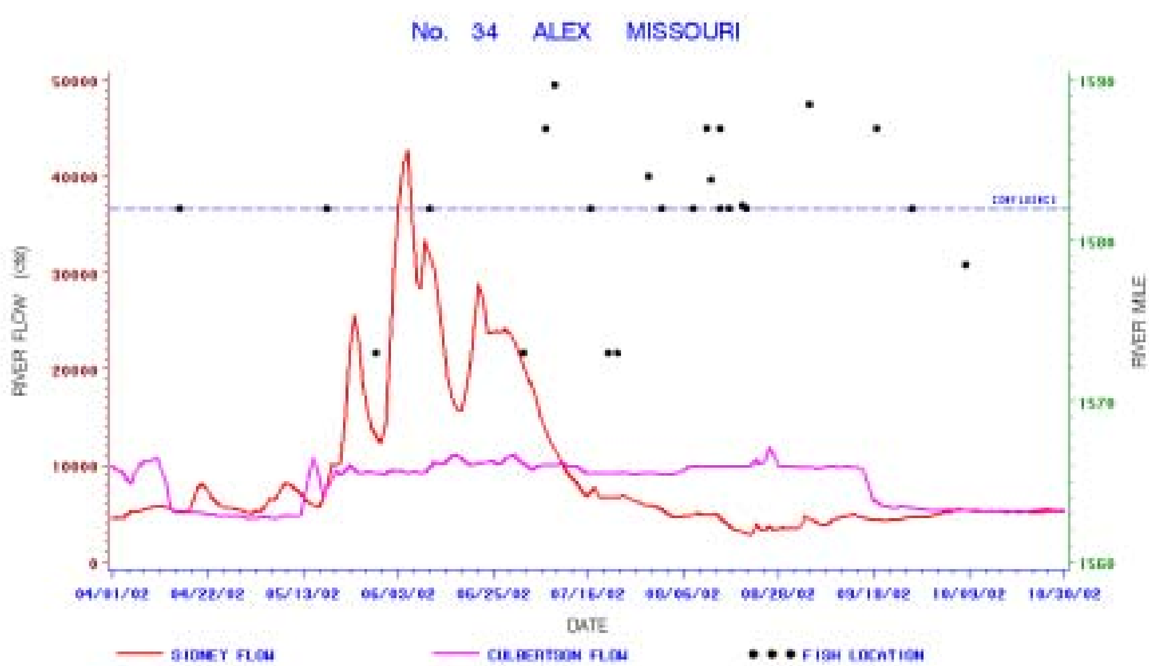

Figure 9: Relocations for Alex, fish # 34, by river mile in the Missouri River plotted against flows from the Sidney and Culbertson gauging stations.

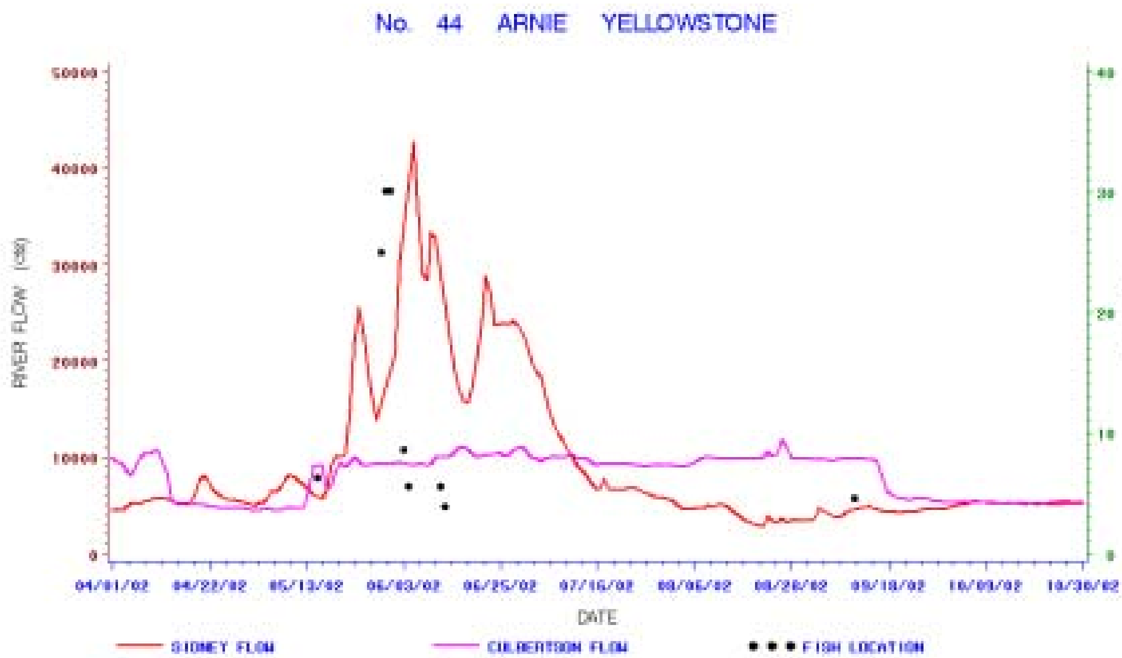

Figure 10: Relocations for Arnie, fish # 44, by river mile in the Yellowstone River plotted against flows from the Sidney and Culbertson gauging stations.

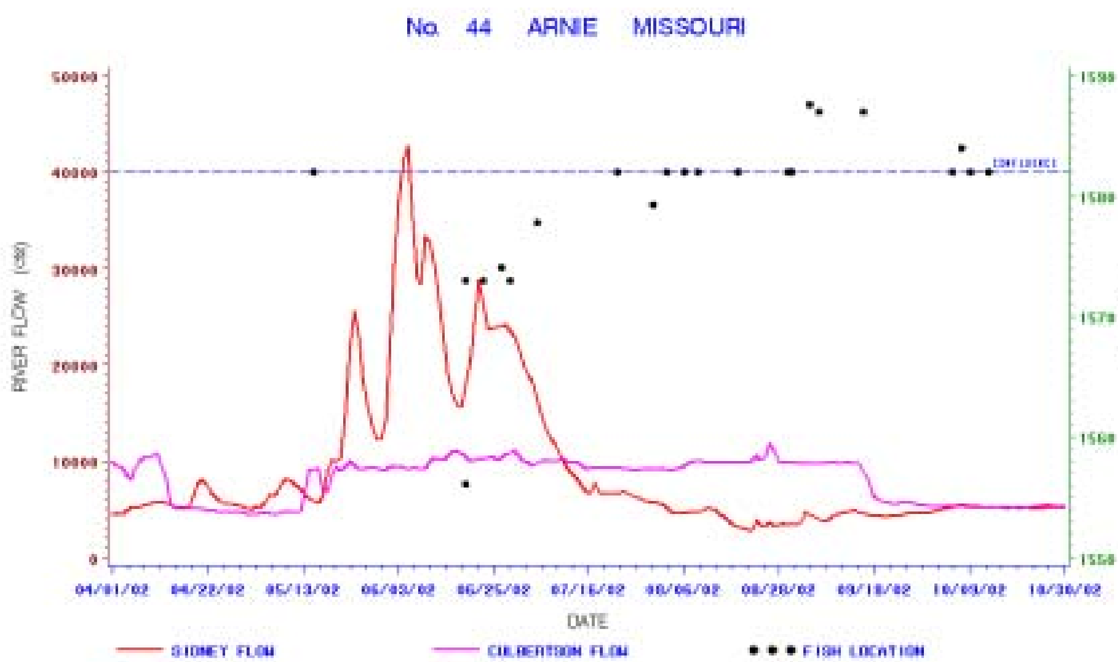

Figure 11: Relocations for Arnie, fish # 44, by river mile in the Missouri River plotted against flows from the Sidney and Culbertson gauging stations.

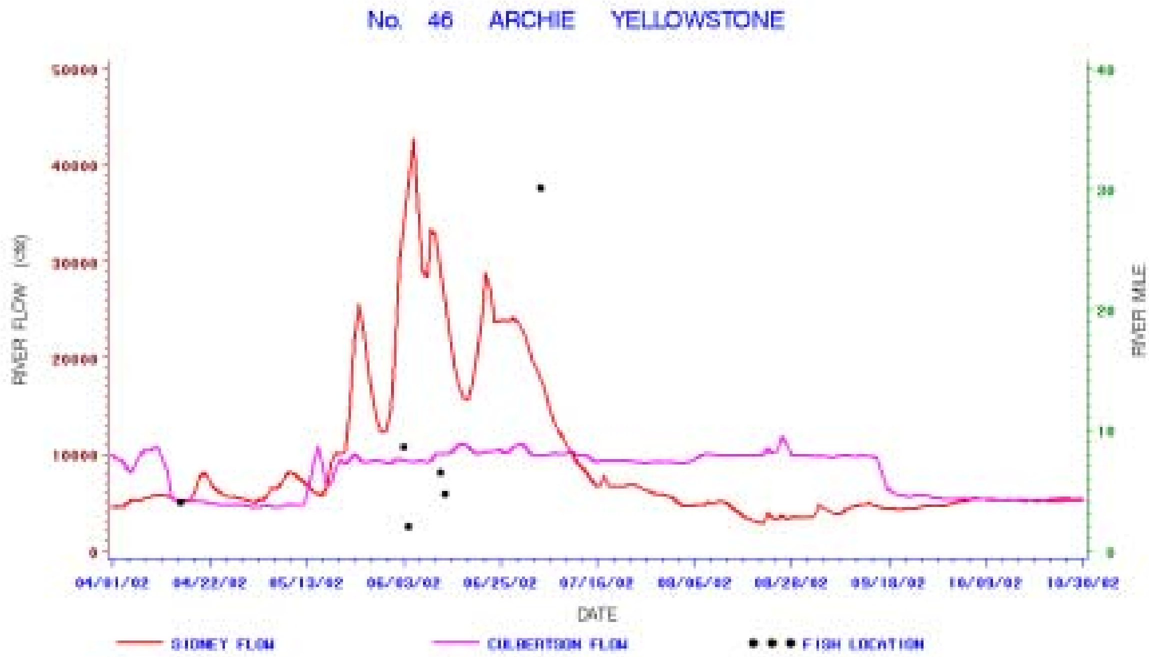

Figure 12: Relocations for Archie, fish # 46, by river mile in the Yellowstone River plotted against flows from the Sidney and Culbertson gauging stations.

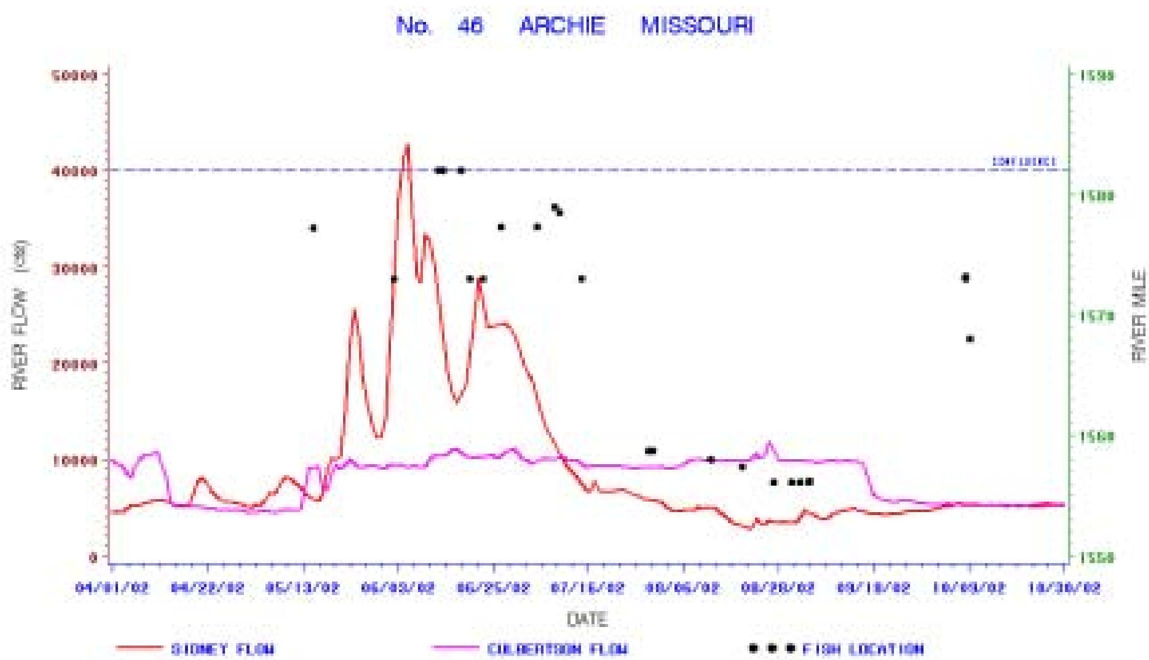

Figure 13: Relocations for Archie, fish # 46, by river mile in the Missouri River plotted against flows from the Sidney and Culbertson gauging stations.

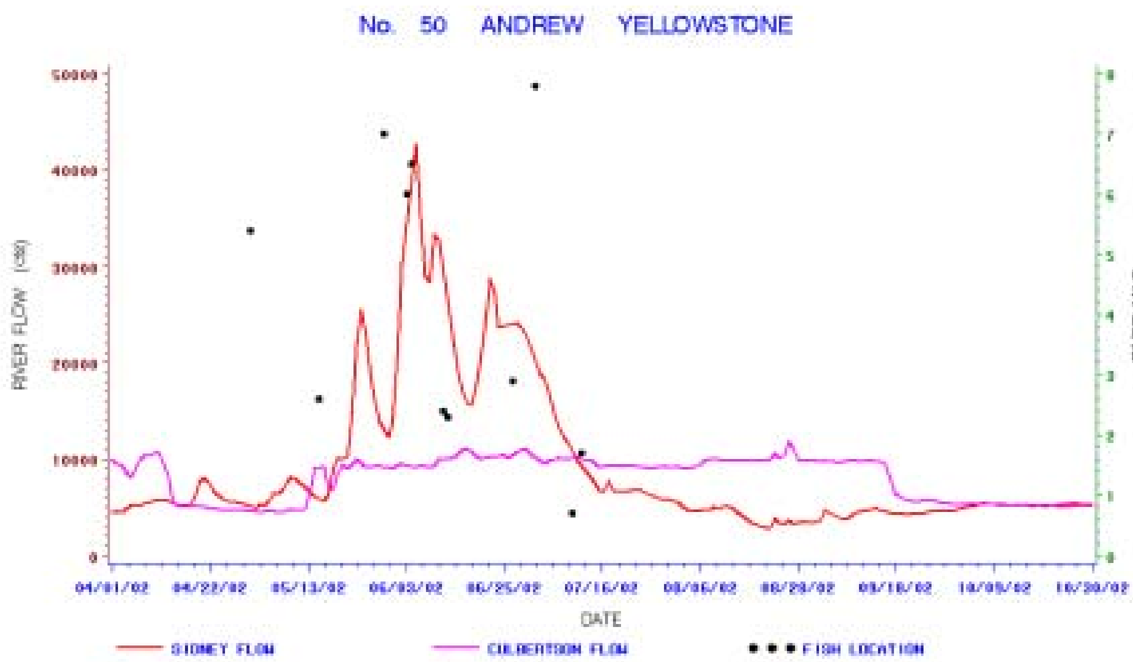

Figure 14: Relocations for Andrew, fish # 50, by river mile in the Yellowstone River plotted against flows from the Sidney and Culbertson gauging stations.

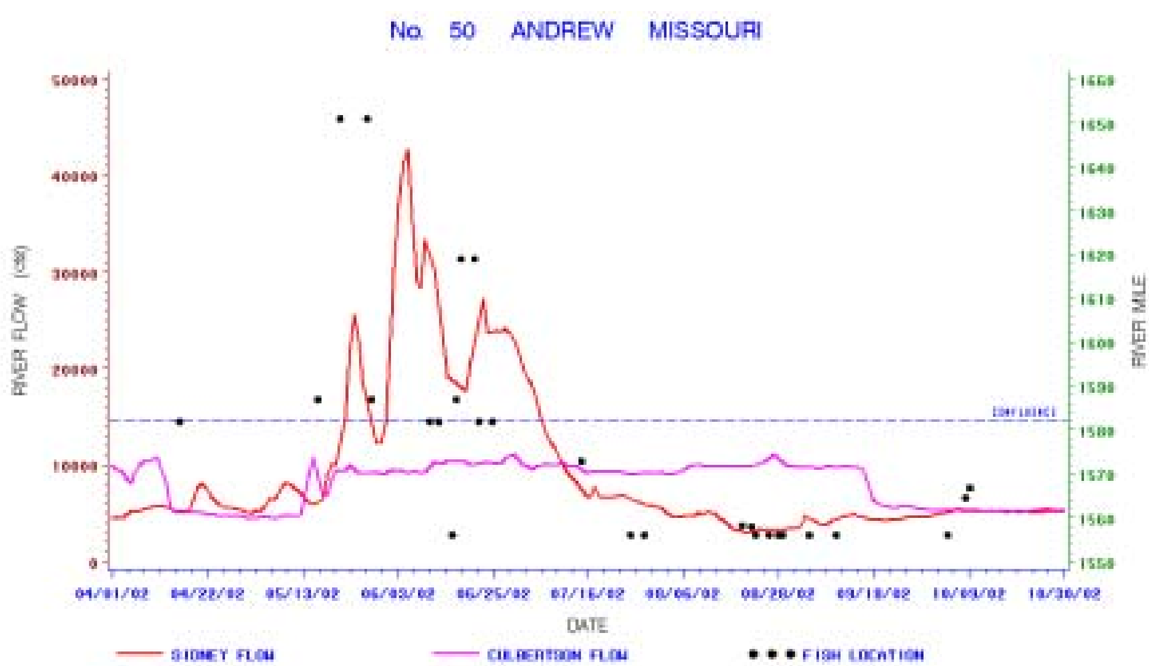

Figure 15: Relocations for Andrew, fish # 50, by river mile in the Missouri River plotted against flows from the Sidney and Culbertson gauging stations.

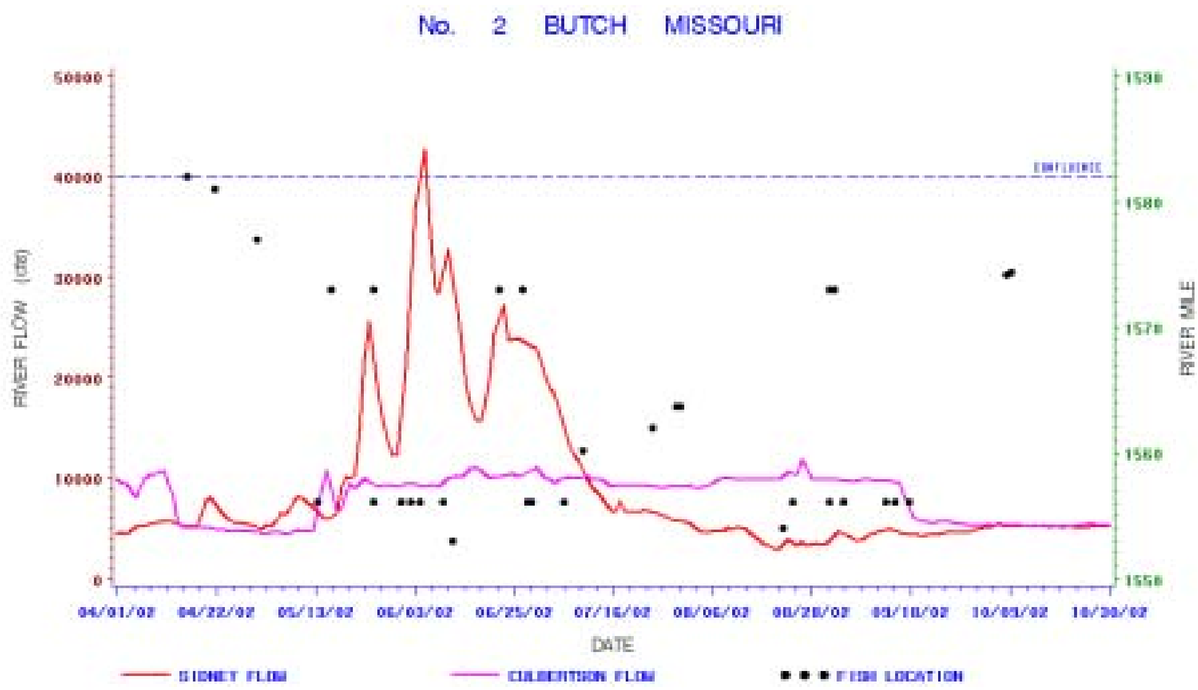

Figure 16: Relocations for Butch, fish # 2, by river mile in the Missouri River plotted against flows from the Sidney and Culbertson gauging stations.

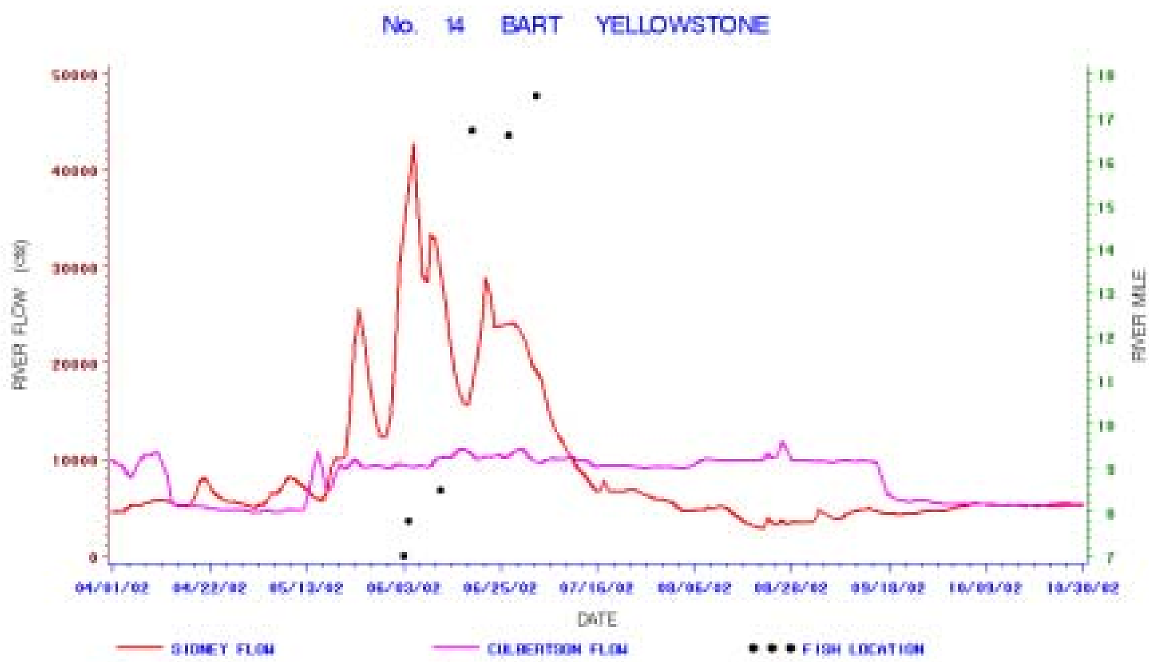

Figure 17: Relocations for Bart, fish # 14, by river mile in the Yellowstone River plotted against flows from the Sidney and Culbertson gauging stations.

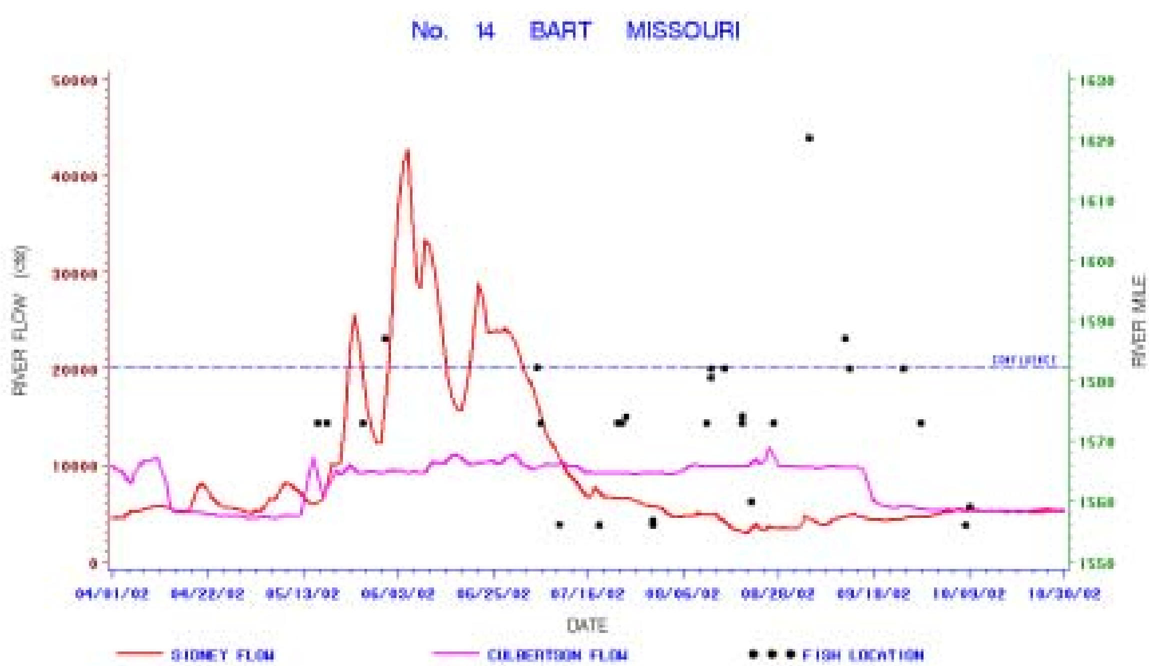

Figure 18: Relocations for Bart, fish # 14, by river mile in the Missouri River plotted against flows from the Sidney and Culbertson gauging stations.

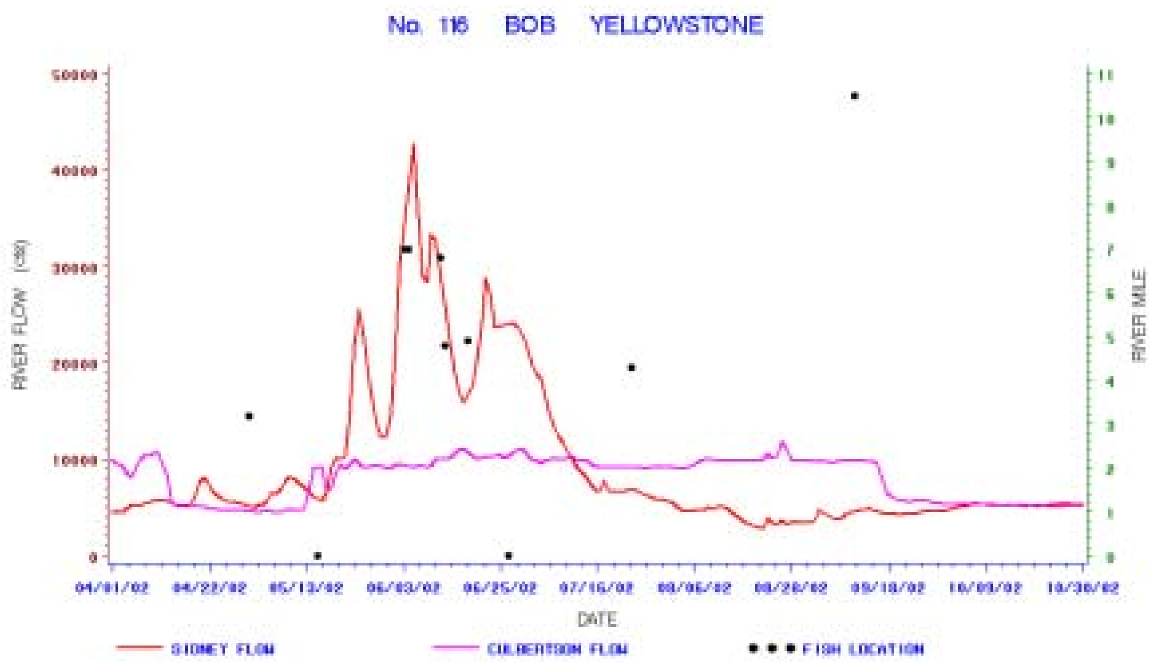

Figure 19: Relocations for Bob, fish # 116, by river mile in the Yellowstone River plotted against flows from the Sidney and Culbertson gauging stations.

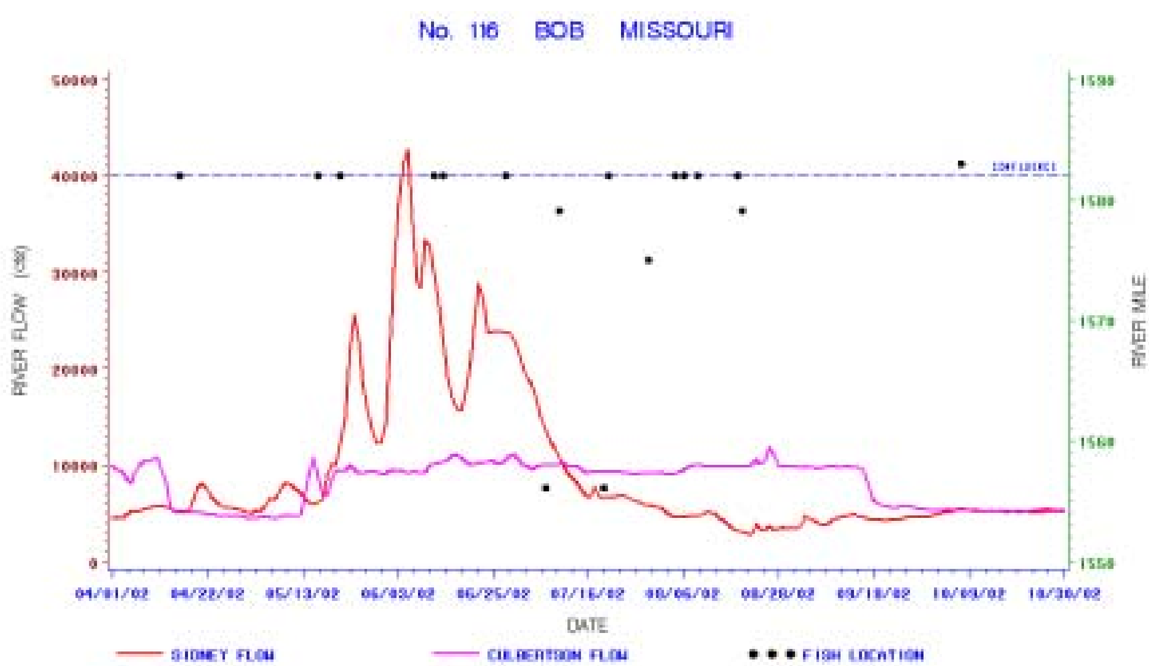

Figure 20: Relocations for Bob, fish # 116, by river mile in the Missouri River plotted against flows from the Sidney and Culbertson gauging stations.

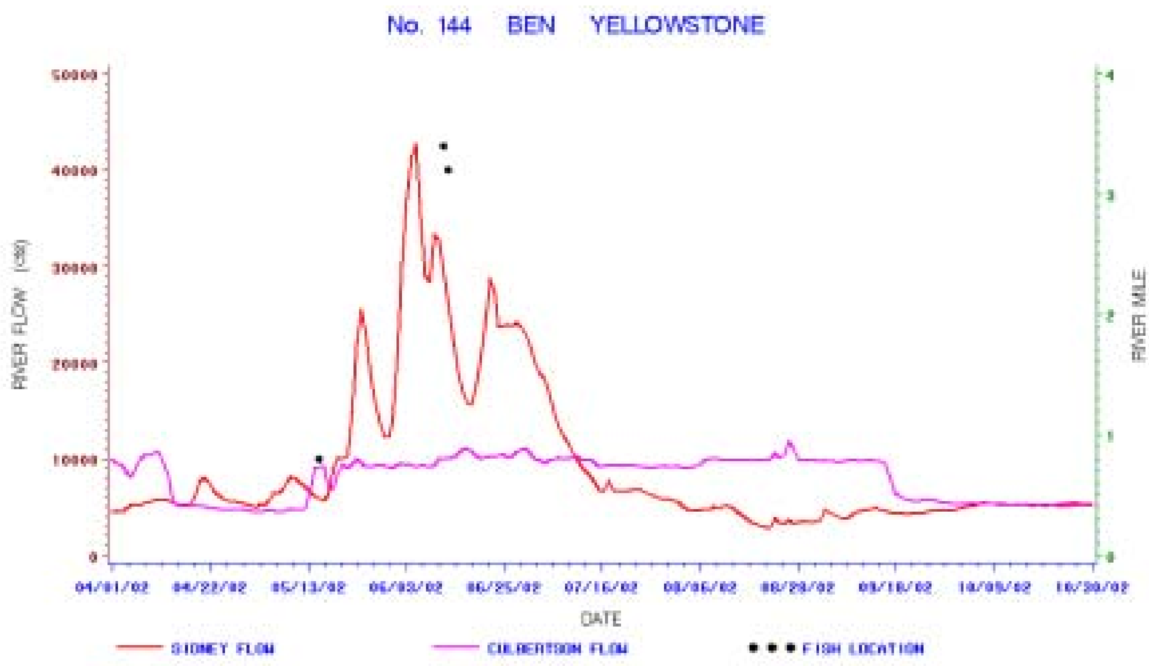

Figure 21: Relocations for Ben, fish # 144, by river mile in the Yellowstone River plotted against flows from the Sidney and Culbertson gauging stations.

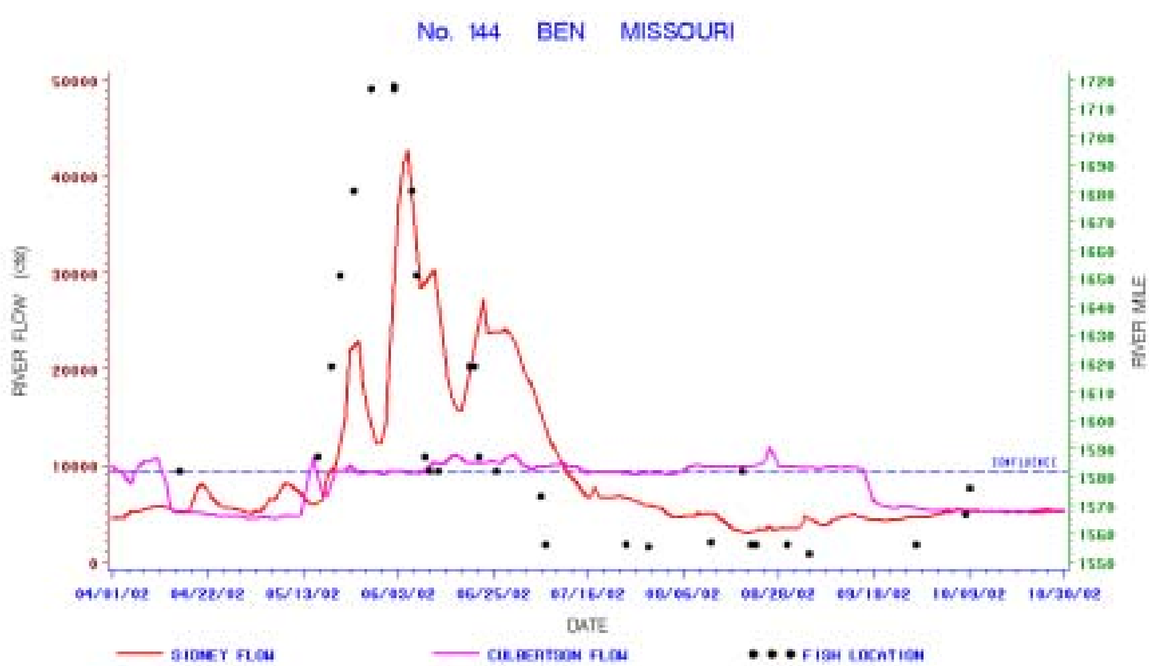

Figure 22: Relocations for Ben, fish # 144, by river mile in the Missouri River plotted against flows from the Sidney and Culbertson gauging stations.

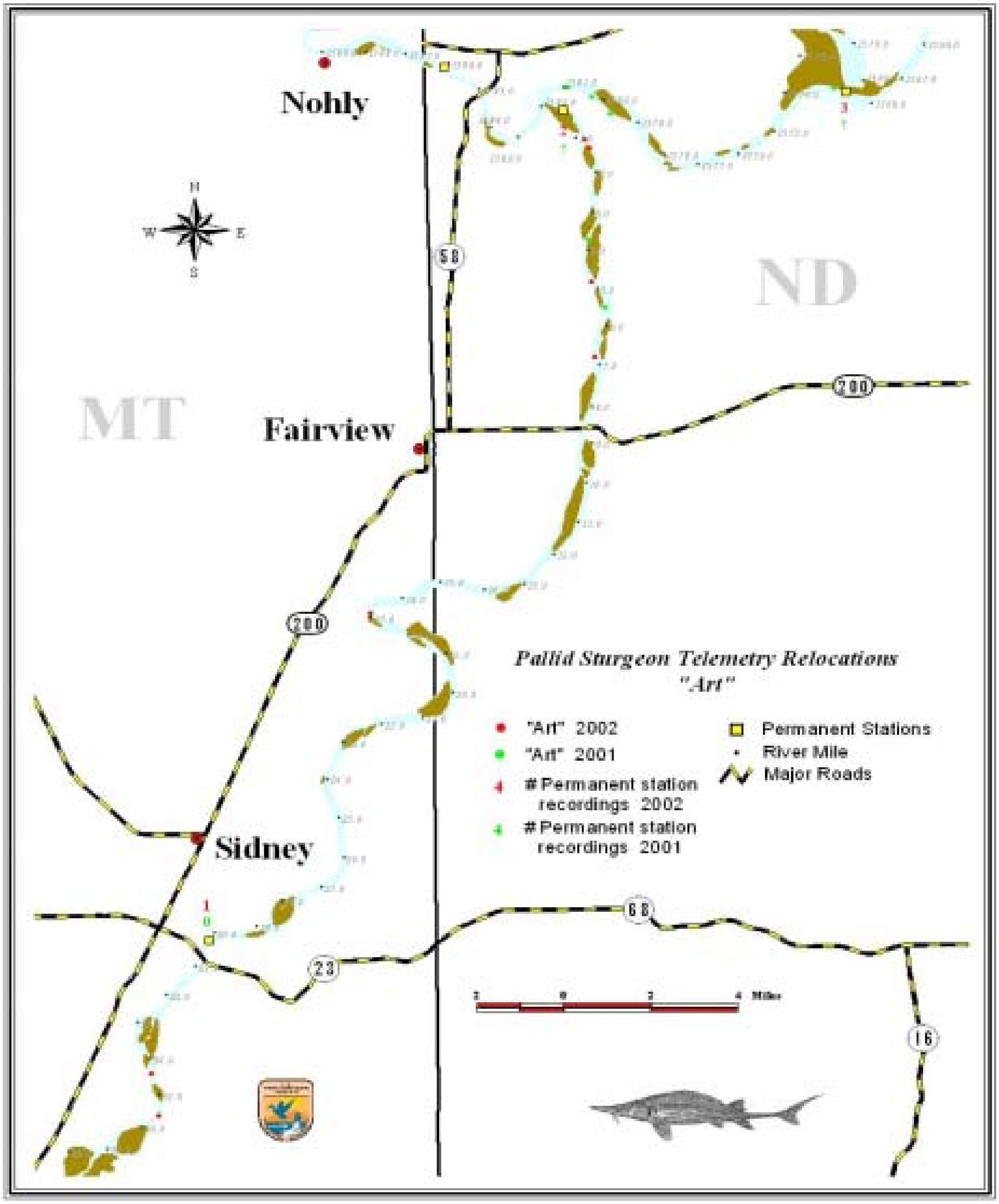

Figure 23: Map of boat relocations and movement frequencies registered for Art passing various fixed datalogging stations for 2001 and 2002.

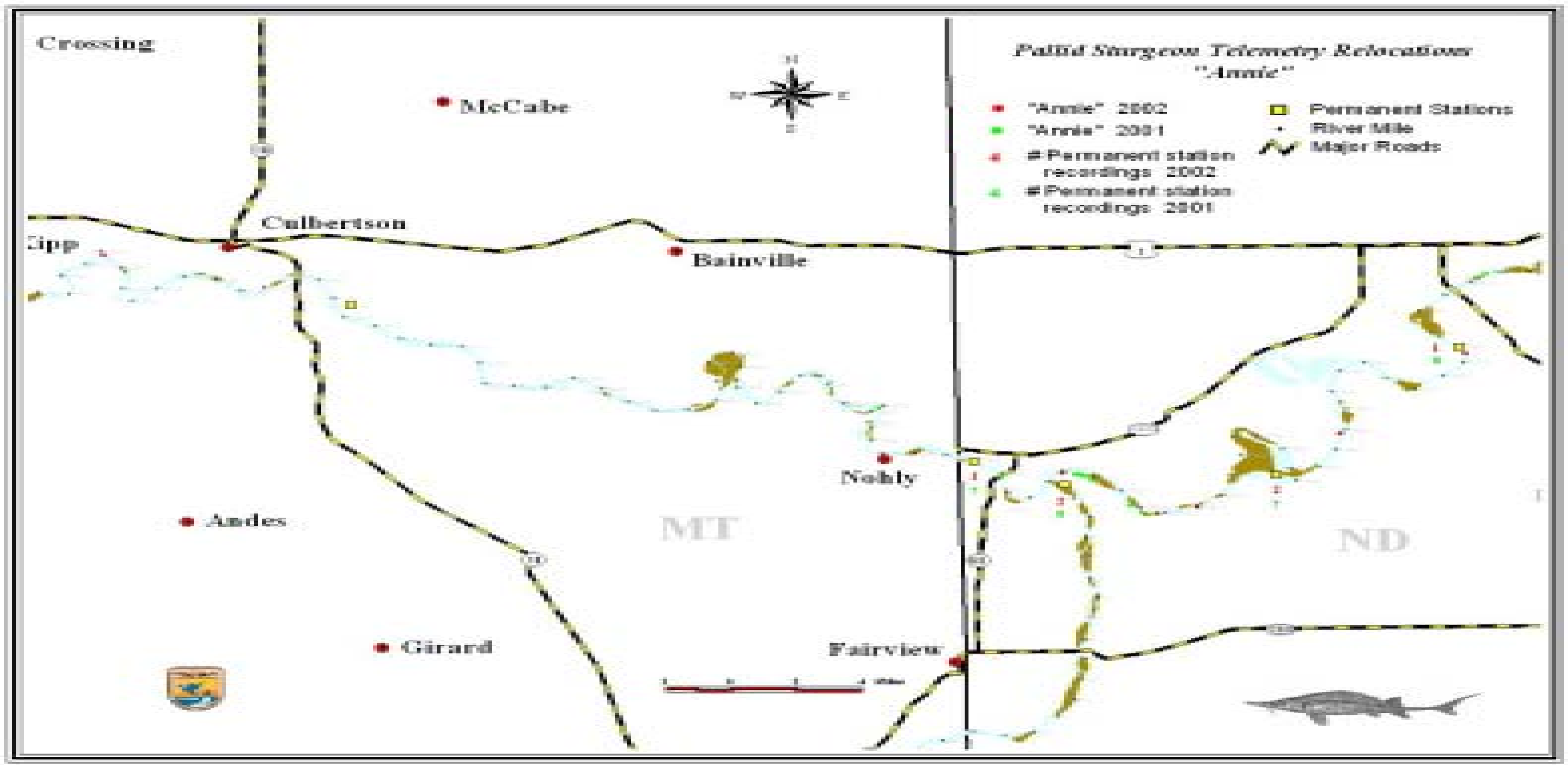

Figure 24: Map of boat relocations and movement frequencies registered for Annie passing various fixed datalogging stations for 2001 and 2002

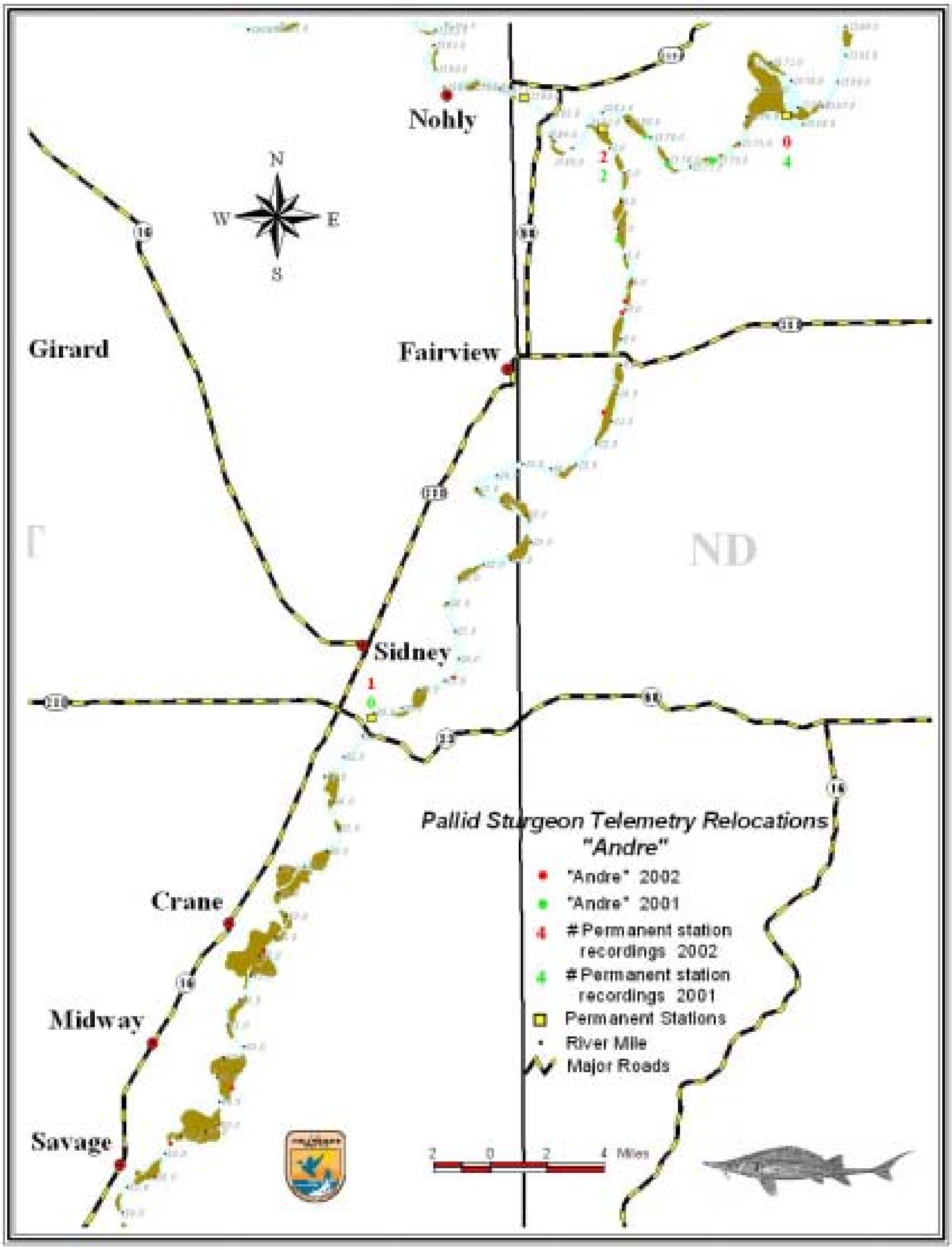

Figure 25: Map of boat relocations and movement frequencies registered for Andre passing various fixed datalogging stations for 2001 and 2002.

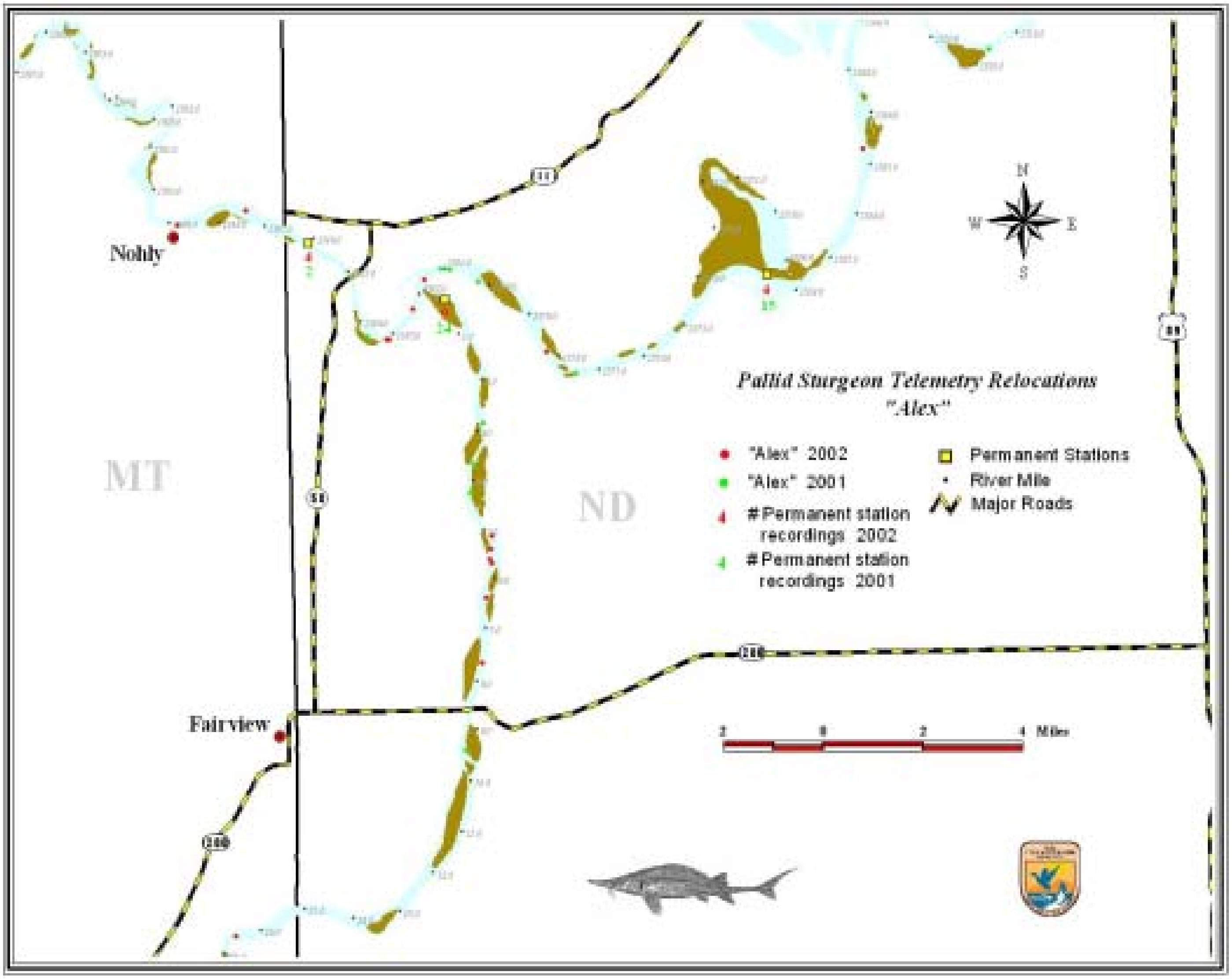

Figure 26: Map of boat relocations and movement frequencies registered for Alex passing various fixed datalogging stations for 2001 and 2002.

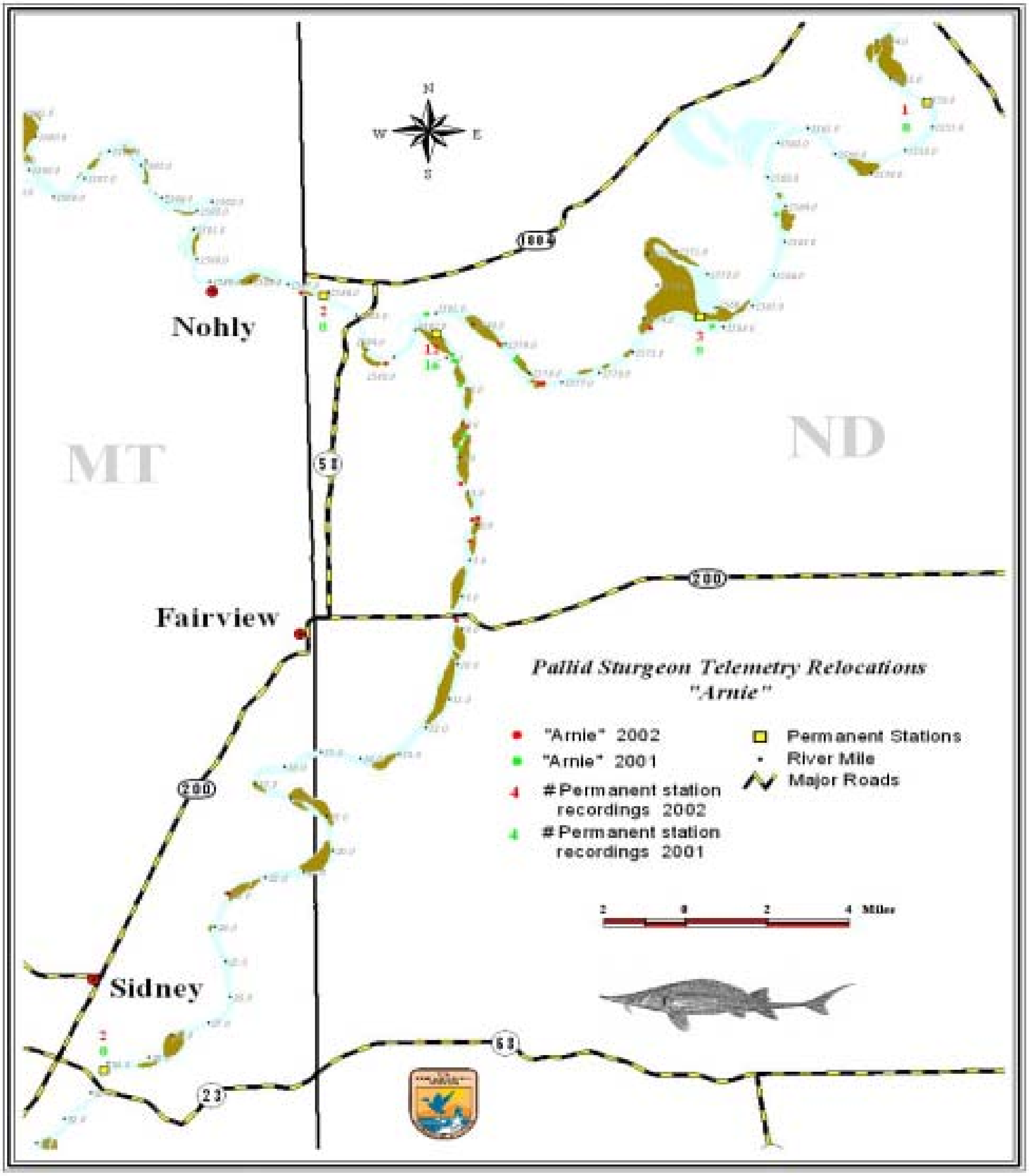

Figure 27: Map of boat relocations and movement frequencies registered for Arnie passing various fixed datalogging stations for 2001 and 2002.

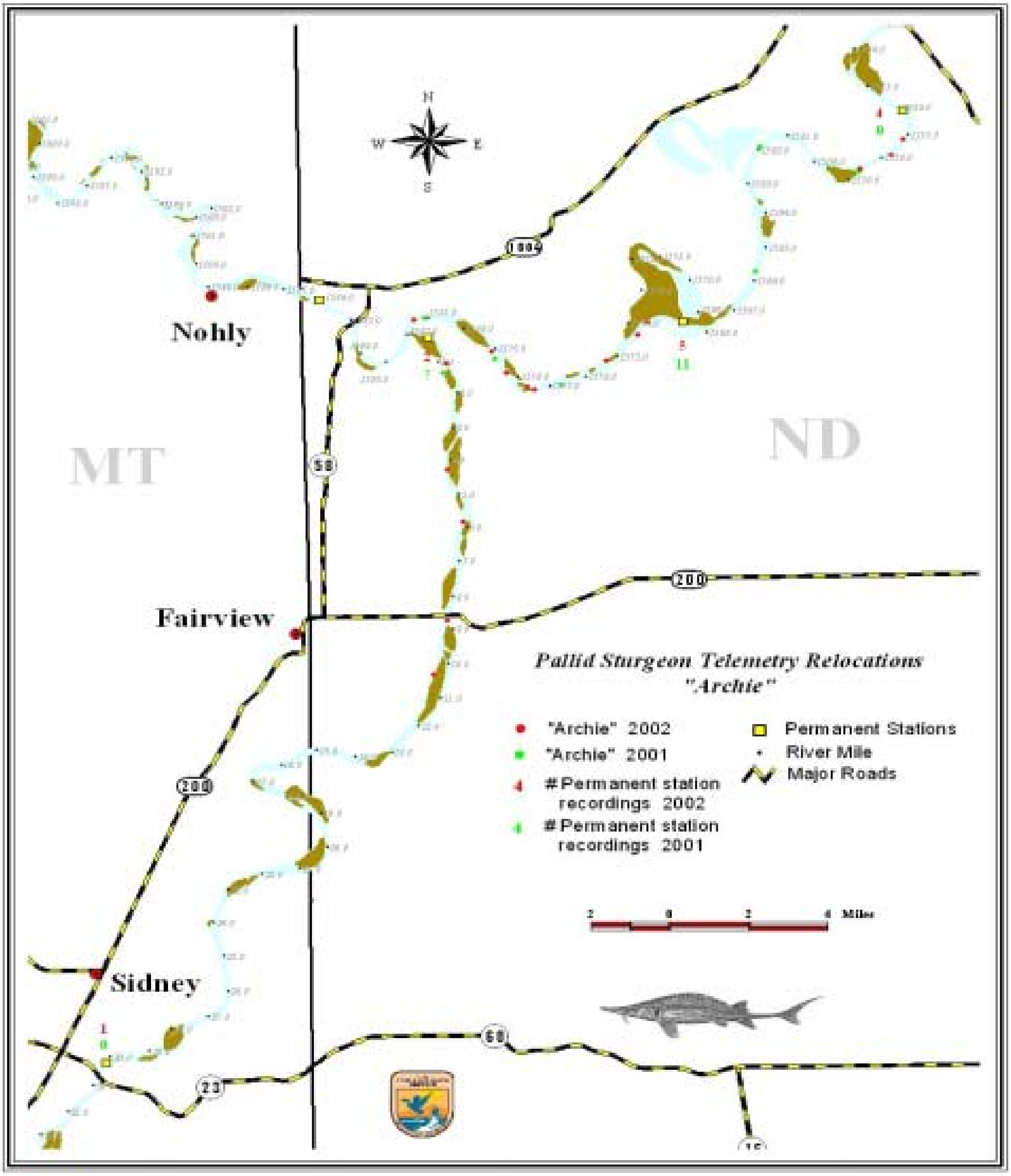

Figure 28: Map of boat relocations and movement frequencies registered for Archie passing various fixed datalogging stations for 2001 and 2002.

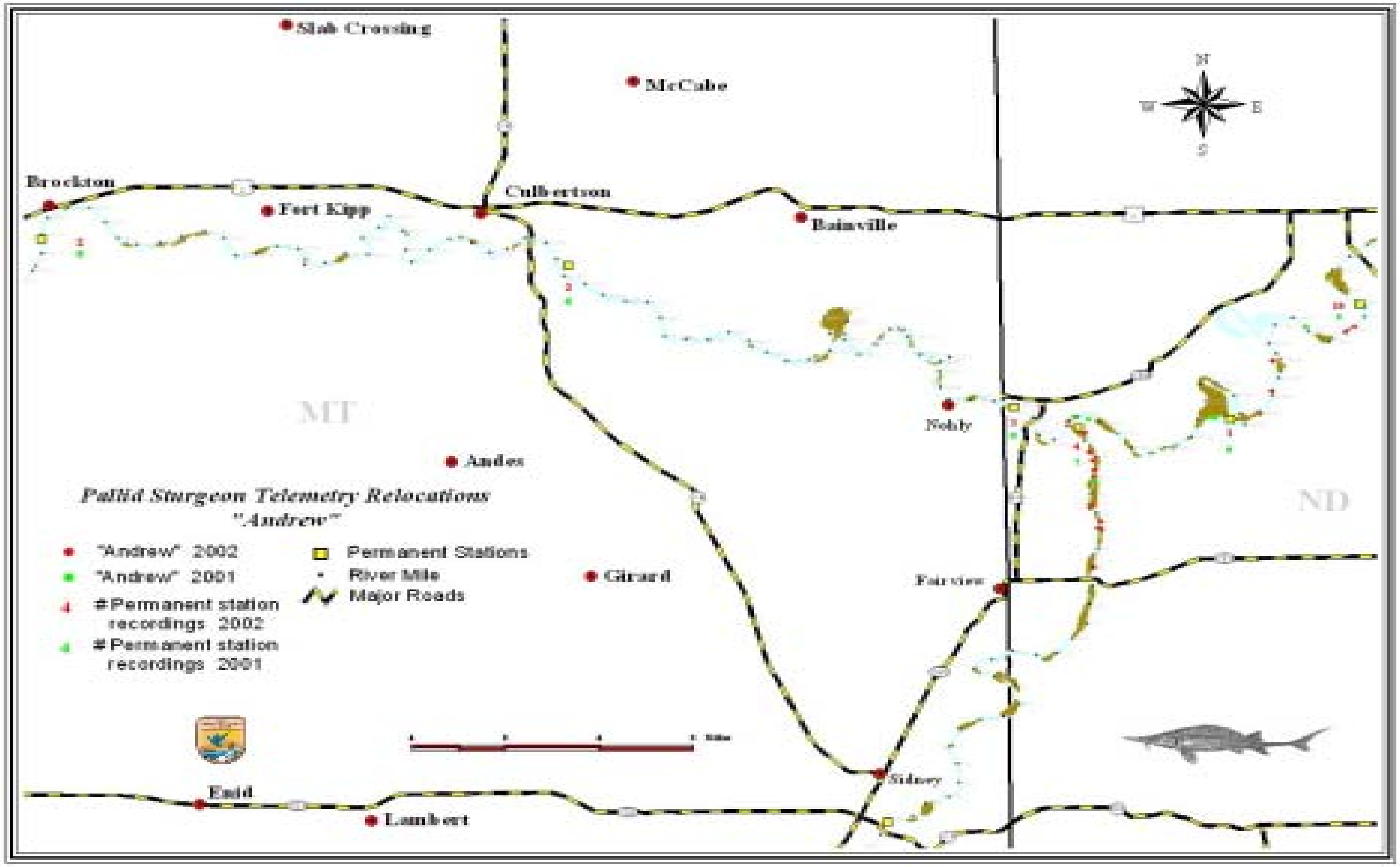

Figure 29: Map of boat relocations and movement frequencies registered for Andrew passing various fixed datalogging stations for 2001 and 2002.

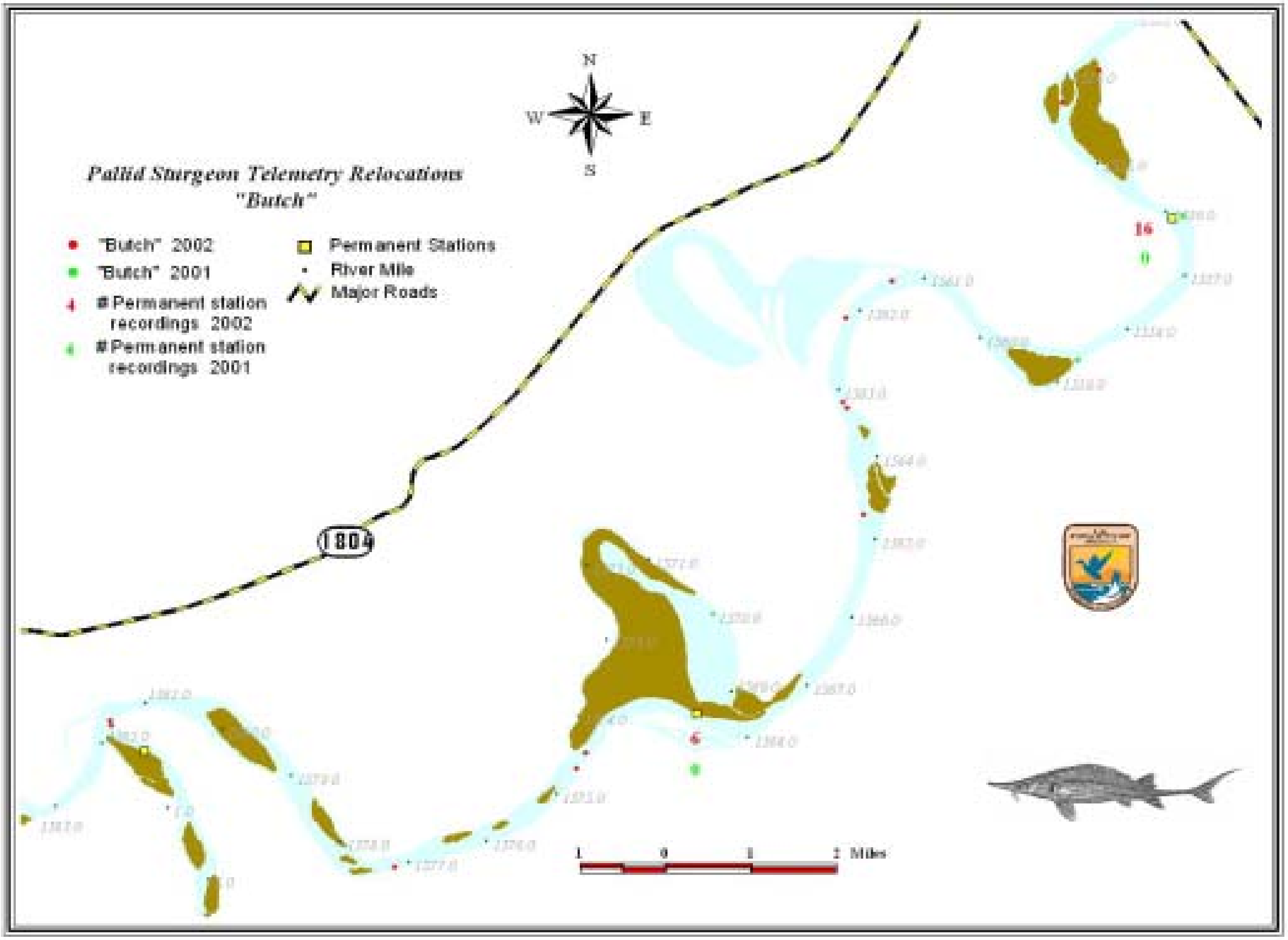

Figure 30: Map of boat relocations and movement frequencies registered for Butch passing various fixed datalogging stations for 2001 and 2002.

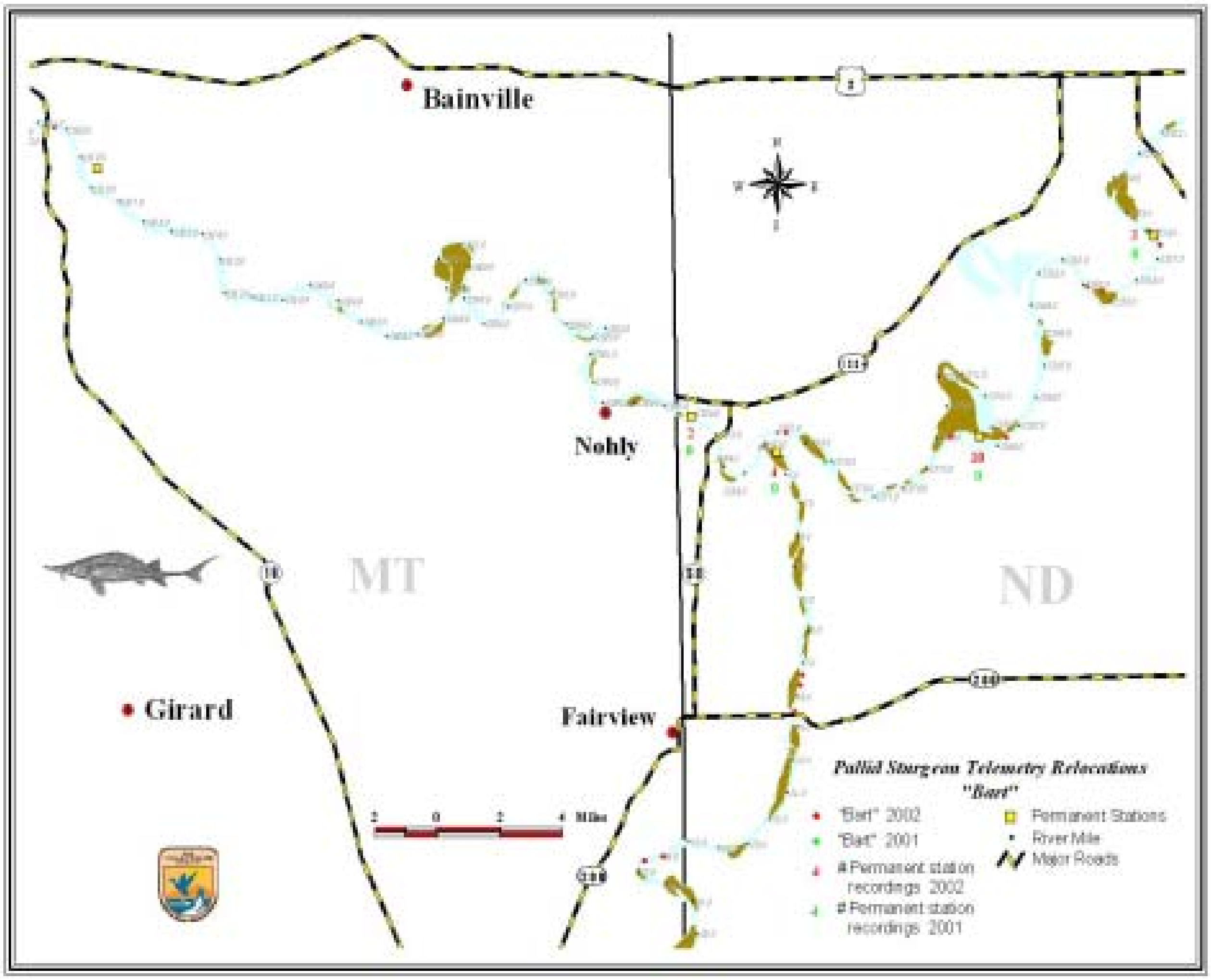

Figure 31: Map of boat relocations and movement frequencies registered for Bart passing various fixed datalogging stations for 2001 and 2002.

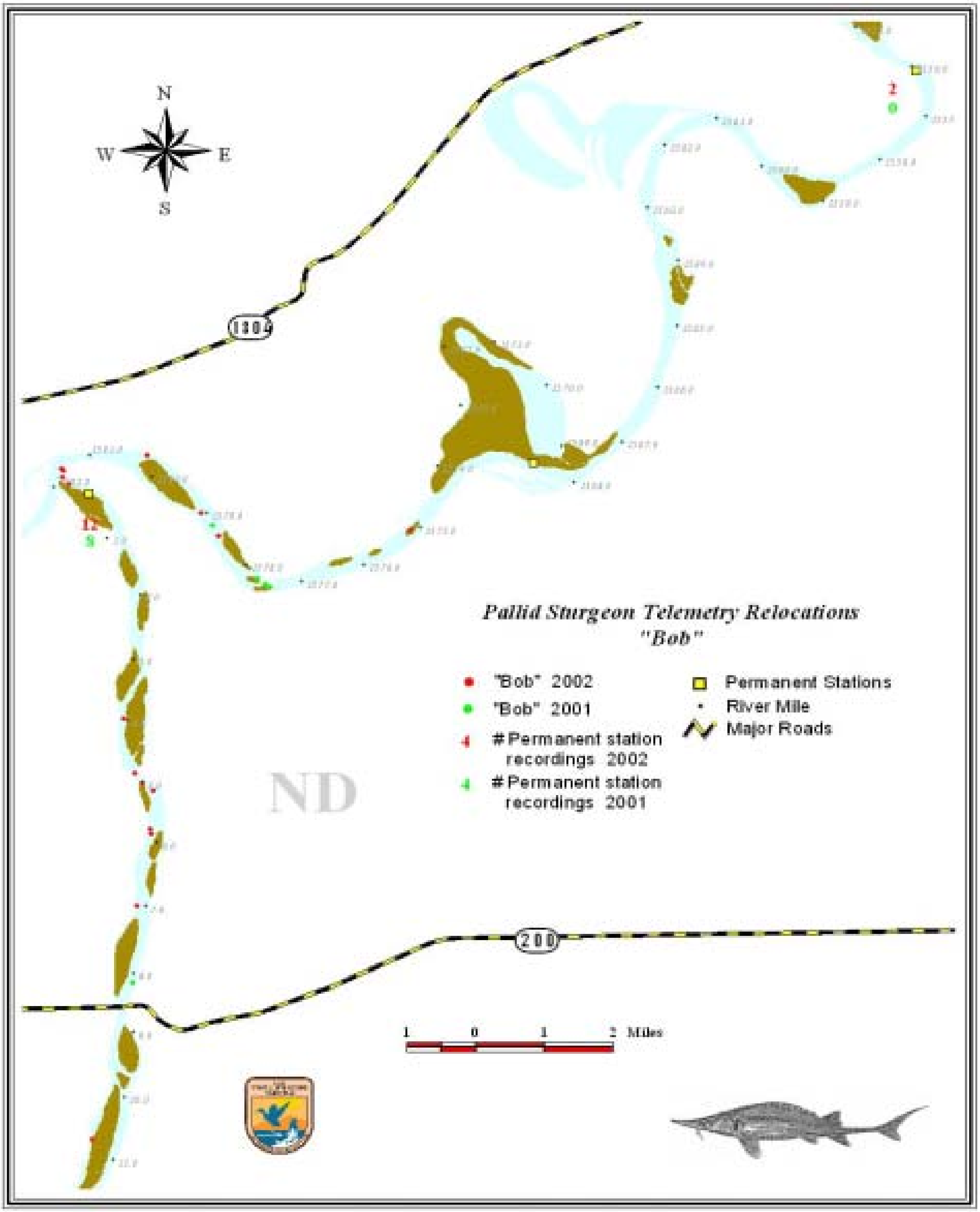

Figure 32: Map of boat relocations and movement frequencies registered for Bob passing various fixed datalogging stations for 2001 and 2002.

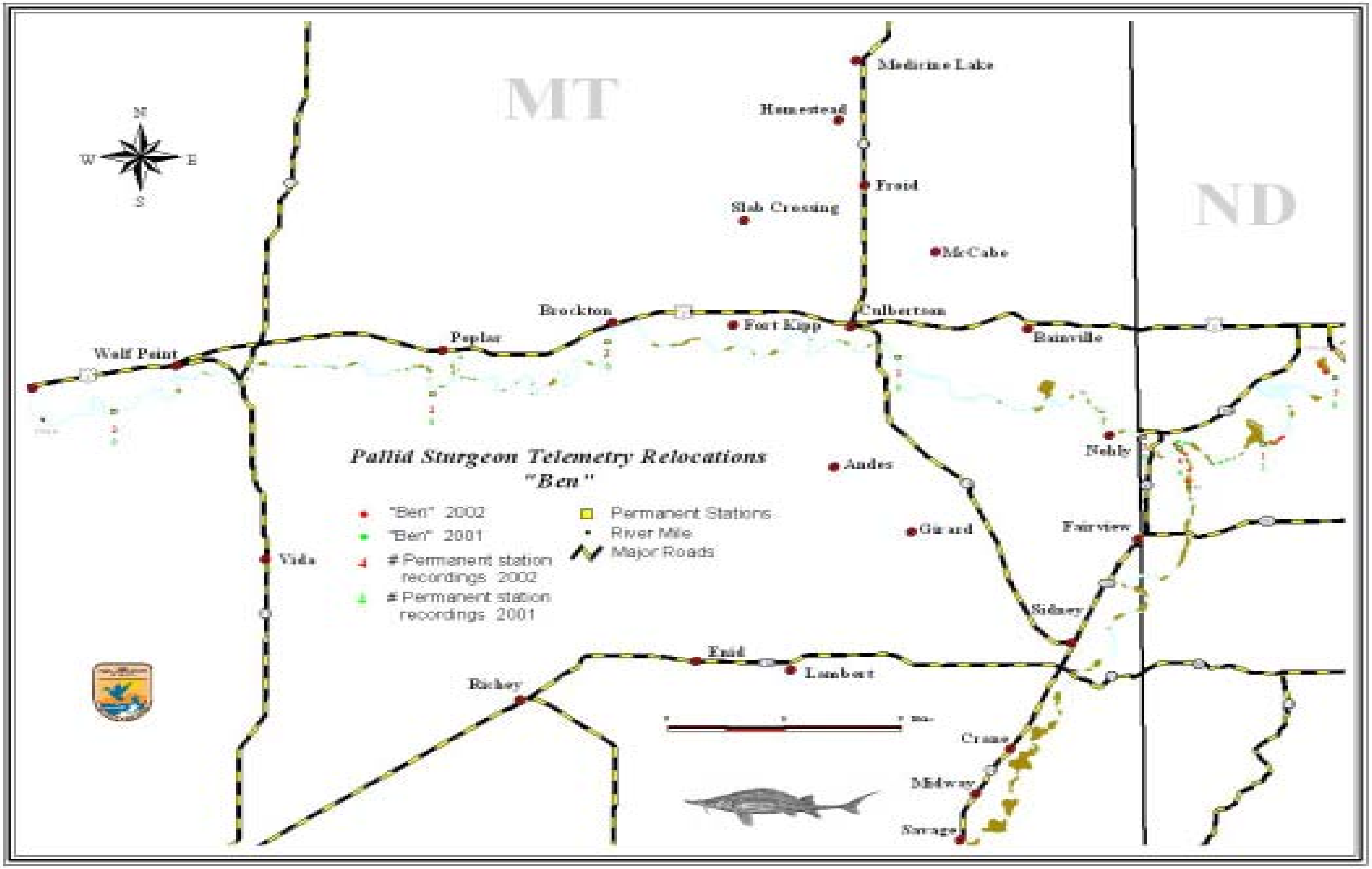

Figure 33: Map of boat relocations and movement frequencies registered for Ben passing various fixed datalogging stations for 2001 and 2002.

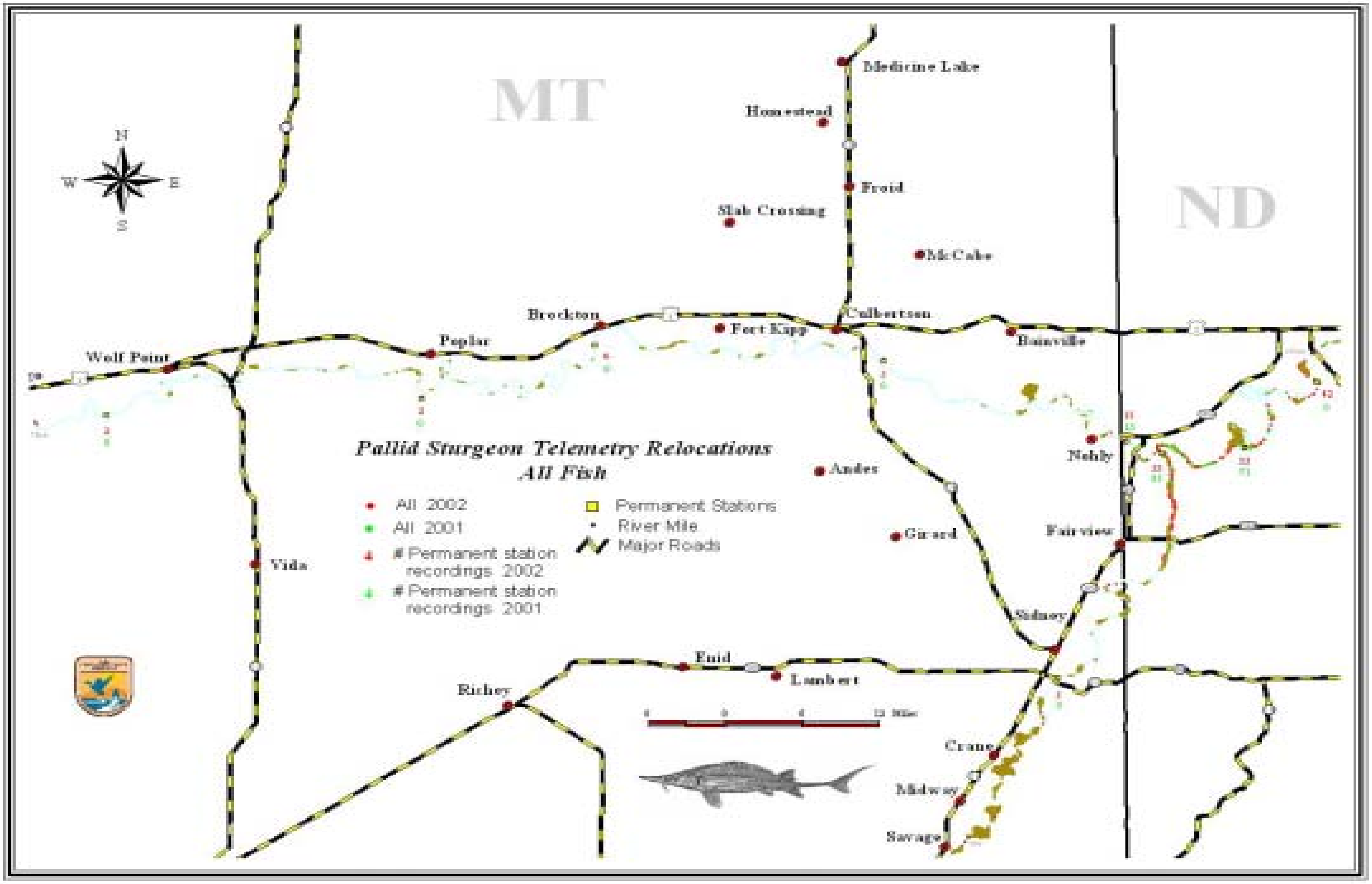

Figure 34: Map of boat relocations and movement frequencies registered for all fish passing various fixed datalogging stations for 2001 and 2002.

INTERIM REPORT ON THE HABITAT USE AND MOVEMENTS OF PALLID STURGEON IN LEWIS AND CLARK LAKE, MISSOURI RIVER, SOUTH DAKOTA

Prepared by the US Fish & Wildlife Service
Great Plains Fish and Wildlife Management Assistance Office
Pierre, SD

STUDY AREA

The riverine reach of Lewis and Clark Reservoir extends approximately 72 km from below Fort Randall Dam to near Springfield, South Dakota where its features become more like a reservoir Figure 1. To aid in sampling, the riverine reach was divided into four sample areas of approximately equal length (Figures 3 -5). The upper site extends from Fort Randall Dam (river mile (RM) 880) to downstream of Greenwood, South Dakota (RM 865) (Figure 2). The upper-middle site extends from RM 865 to near Verdel, Nebraska (RM 856) (Figure 3) and the lower-middle site extends from RM 856 to Running Water, South Dakota (RM 845) (Figure 4). The lower site comprises the remainder of the river (RM 845 to near Springfield, SD) (Figure 5). The fifth sample site is Lewis and Clark Reservoir from downstream of Springfield, SD to Gavins Point Dam. If all fish are found to remain in the riverine reach, this section will be excluded as a sample site.

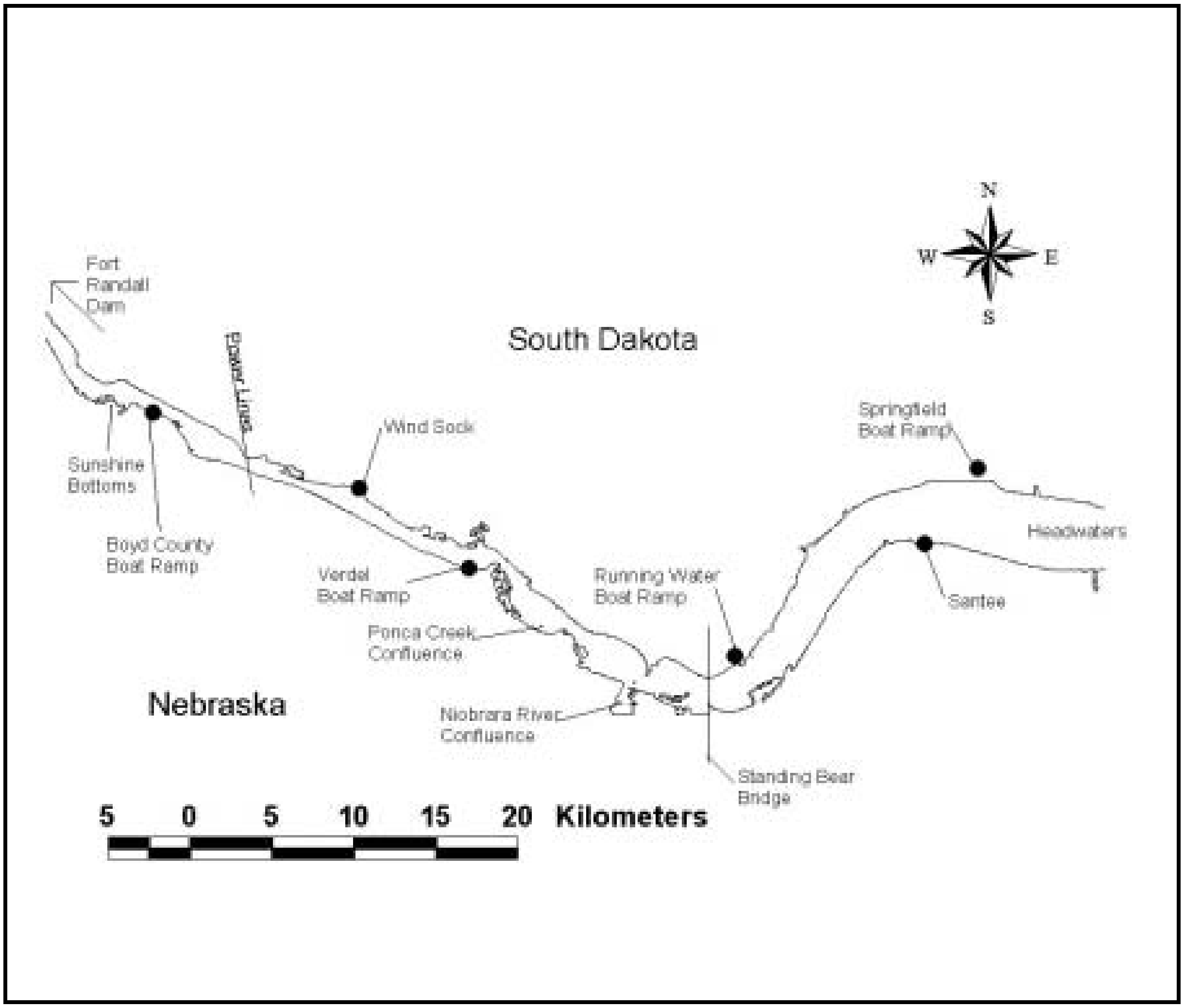

Figure 1. Lewis and Clark Lake, S D.

METHODS

In 2000, six adult and 50 juvenile pallid sturgeon, *Scaphirhynchus albus*, were surgically implanted with a sonic transmitter and a PIT tag at Gavins Point National Fish Hatchery. Each transmitter emits a unique code specific to an individual fish, and has a life expectancy of 36 months. These fish were held several weeks, following implantation to determine tag retention and survival rates. Following this holding period, surviving fish were transported and released, near Verdel, NE, in the riverine portion of Lewis and Clark Reservoir.

Two tracking methods are employed during each sample period; extensive and intensive. Extensive tracking involves the location of as many fish as possible per zone, and intensive tracking is the following of a few fish for the entire tracking period. During each sample period, at least two zones were tracked extensively, and at least one fish intensively. Tracking began immediately post stocking and continued bi-monthly, i.e. every other week, until weather conditions prohibited tracking during the winter months. Tracking will resume as early as feasible in the spring. All sample zones and sample periods are selected at random to reduce bias. An ultrasonic receiver and directional hydrophone were used to determine fish locations. A location was recorded when the coded impulses from the sonic transmitter became equally audible with a 360^{o} rotation of the hydrophone. Once a fish location was determined, latitude and longitude coordinates were recorded with a PLGR+96 Global Positioning System (GPS) receiver and habitat types were assigned. The habitat types were designated as: main channel, side channel, backwater, island, reservoir, tributary mouths, and tailrace. Combinations of these descriptors may be necessary to get specific habitat types like side channel island, or main channel island. Tracking in tributaries will be conducted if deemed necessary, and will be recorded as a separate habitat type. Along with the habitat types, surface water temperature, flow at 0.2 and 0.8 times water depth and at bottom, turbidity, and percent maximum depth were collected at fish relocation sites. Percent maximum depth is the ratio of the fish depth relative to the maximum cross sectional depth where the fish is located.

Diel movement patterns were determined by dividing a 24 h period into four sub-periods; dawn (1 h before to 1 h after sunrise), day (2 h after sunrise to 2 h before sunset), dusk (1 h before sunset to 1 h after sunset) and night (2 h after sunset to 2 h before sunrise). The tracking periods were determined randomly, and as many fish as possible were followed during that time. Water level fluctuations and poor visibility made night tracking difficult due to decreased flows and safety. To minimize risk, night time tracking was conducted in conjunction with dusk and dawn periods. This allowed biologists to begin tracking during daylight hours and finish tracking during daylight hours. The GPS coordinates and habitat types for each relocated fish were recorded approximately every hour. Tracking is planned to continue through the spring of 2003 which is when we expect all of the transmitters to be too weak to relocate .

RESULTS

Twenty-two of the fifty juveniles and the six adults survived the tagging operation and holding period. Following the 2000 sampling, 16 of the 22 juveniles and 4 of the 6 adults have been relocated at least once. During 2001, three additional juveniles were located for the first time, increasing the total number of relocated juveniles to19. However, only 2 of the 4 adults were found this year. The following data summarizes what has been found to date (Table 1).

Habitat

In 2000, all fish were relocated in main channel habitats. During 2001, there were 2 fish locations recorded at the confluence of the Missouri and Niobrara Rivers as well as a few locations documented in side-channel habitats. Until 2002, no fish had been located in the reservoir proper or the river marsh area immediately around Springfield, SD. In fact, the downstream most relocation was approximately 5 km below Running Water, SD. This year we began consistently relocating fish in the river marsh area immediately around the Springfield, SD area.

In 2002, we worked in cooperation with the US Geological Survey, Columbia, Missouri, to develop bathymetric maps and side scan imagery of sites where pallid sturgeon were most often relocated. This data will be useful for quantifying bottom substrate profiles, flow conditions, and physical features of preferred pallid sturgeon habitat.

Movement

Similar to 2001 and 2002, most fish stayed within a few hundred meters of their original location during intensive tracking (Table 2). However, seasonally the fish moved about substantially (Figures 2-24). During January - April (Figures 6 - 24) fish were mainly found in the middle section (sample zones 2 and 3) of the study area. By May, fish were also located in the upper section (sample zone 1) of the study area where they remained through June. Beginning in July the fish appeared to disperse from the upper reaches and were found in all zones by early September. By late September fish were generally relocated downstream of their previous relocationsites. This pattern of moving upstream in the spring and dispersing throughout the system in the fall suggests some type of migratory behavior. Because these fish are from the 1997 year class, it may be assumed that they are immature and not moving for spawning purposes. More likely, the movements were associated with flows from dam operations. This behavior will be statistically analyzed when the study is completed in 2003 at which time a sufficient sample size should have been obtained for analysis.

Table 1. Summary of data collected at pallid sturgeon locations below Fort Randall Dam, South Dakota during 2001 and 2002. Adult and juvenile data are combined.

	2001	**2002**
Turbidity (NTU=s)	3.3-36.8 (mean 6.2, SE=1.9)	1-26.4 (mean 6.4, SE=0.33)
Mean depth of location (m)	3.6 m (N=29, SE=0.231)	3.8 m (N=115, SE=0.18)
Percent maximum depth	30.6-100 (mean 58.2, SE=3.5)	2.5 - 100 (mean 77.5, SE=1.88)
Column velocity (cm/sec)	data not collected	6.8-108 (mean 57.3 (SE=2.24)
Bottom flows (cm/sec)	5.3-42.1 (mean 17.6, SE=2.02)	5-106 (mean 47.0, SE=2.14)

Table 2. Summary of pallid sturgeon movement data collected below Fort Randall Dam, South Dakota during 2001 and 2002. Adult and juvenile data are combined.

	2001	**2002**
Average distance moved (m/hr) All periods combined	239.7 (SE=49.2)	55.5 (SE=8.1)
Average distance moved (m/hr) Dawn	103.8 (N=2, SE=27)	84.3 (N=15, SE=23.1)
Average distance moved (m/hr) Day	264.9 (N=24, SE=63.3)	34.2 (N=51, SE=6.3)
Average distance moved (m/hr) Dusk	312.3 (N=12, SE=182.7)	50.2 (N=15, SE=15.5)
Average distance moved (m/hr) Night	119.1 (N=10, SE=27)	50.3 (N=22, SE=18.6)

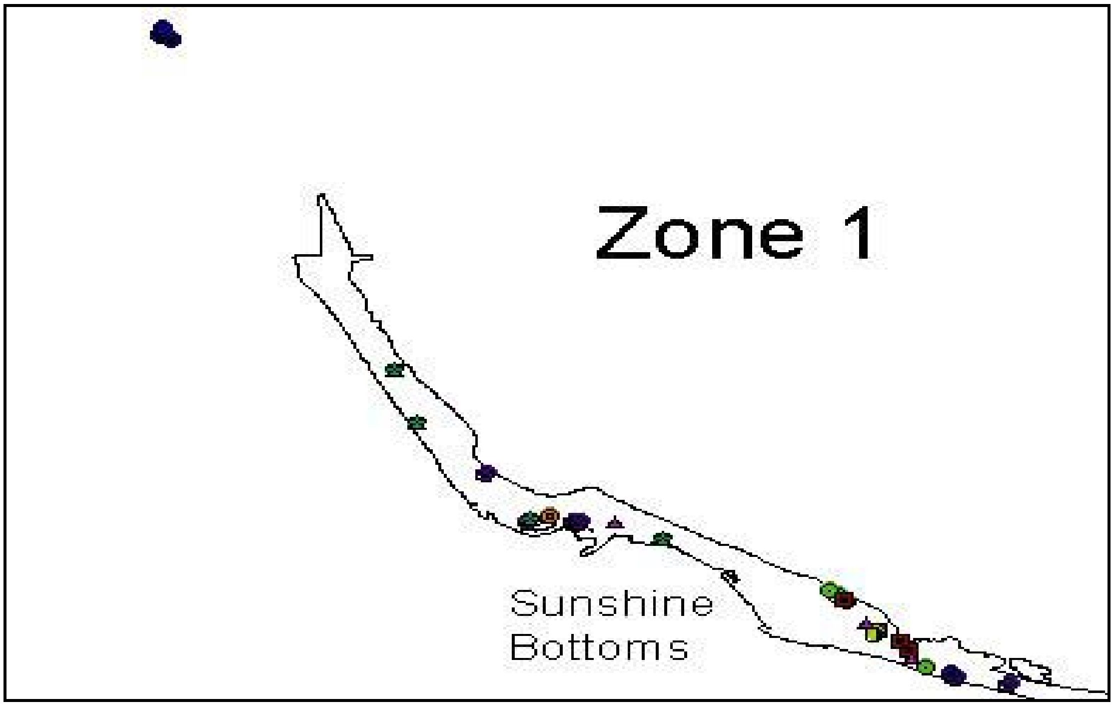

Figure 2. Pallid sturgeon relocation sites in Zone 1, Lewis and Clark Lake, SD during 1992.

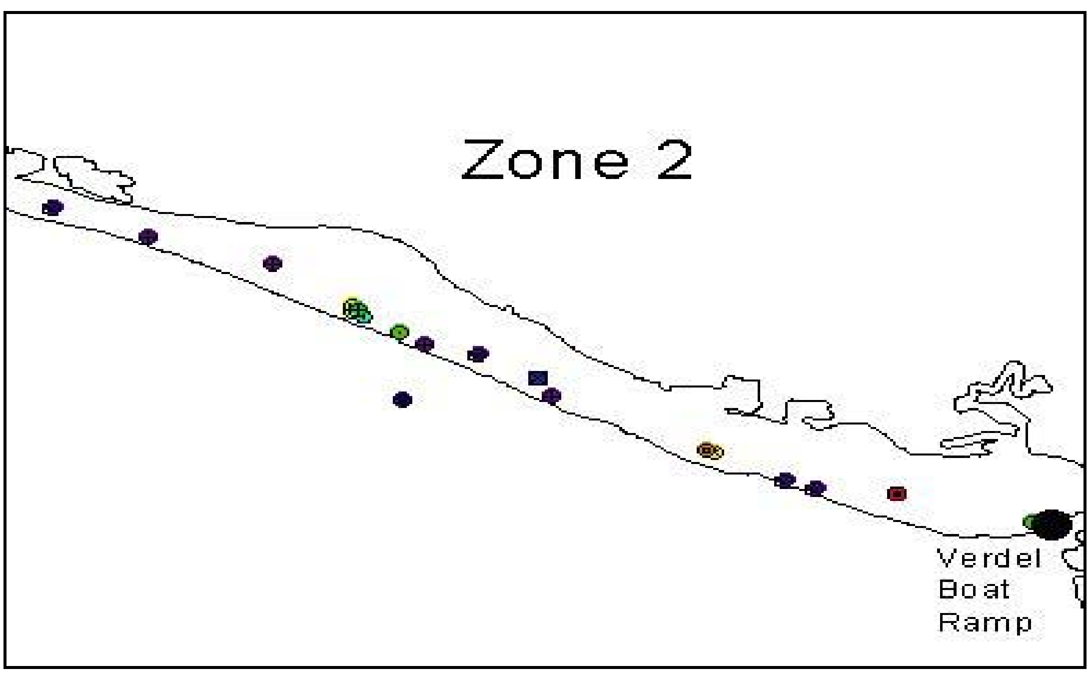

Figure 3 Pallid sturgeon relocation sites in zone 2, Lewis and Clark Lake, SD during 1992.

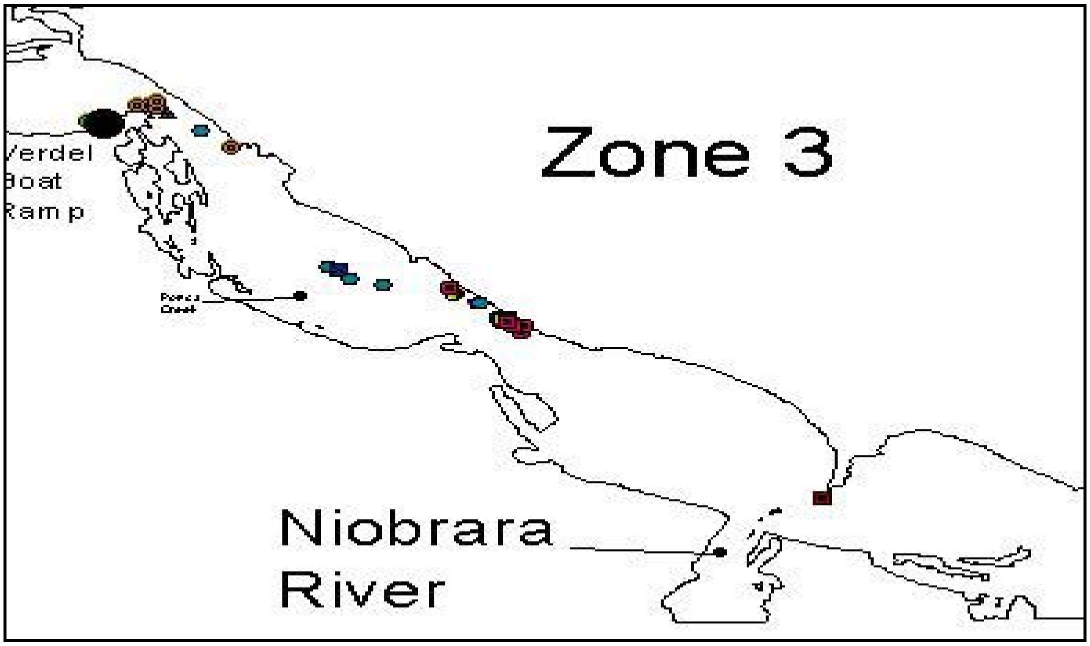

Figure 4. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992.

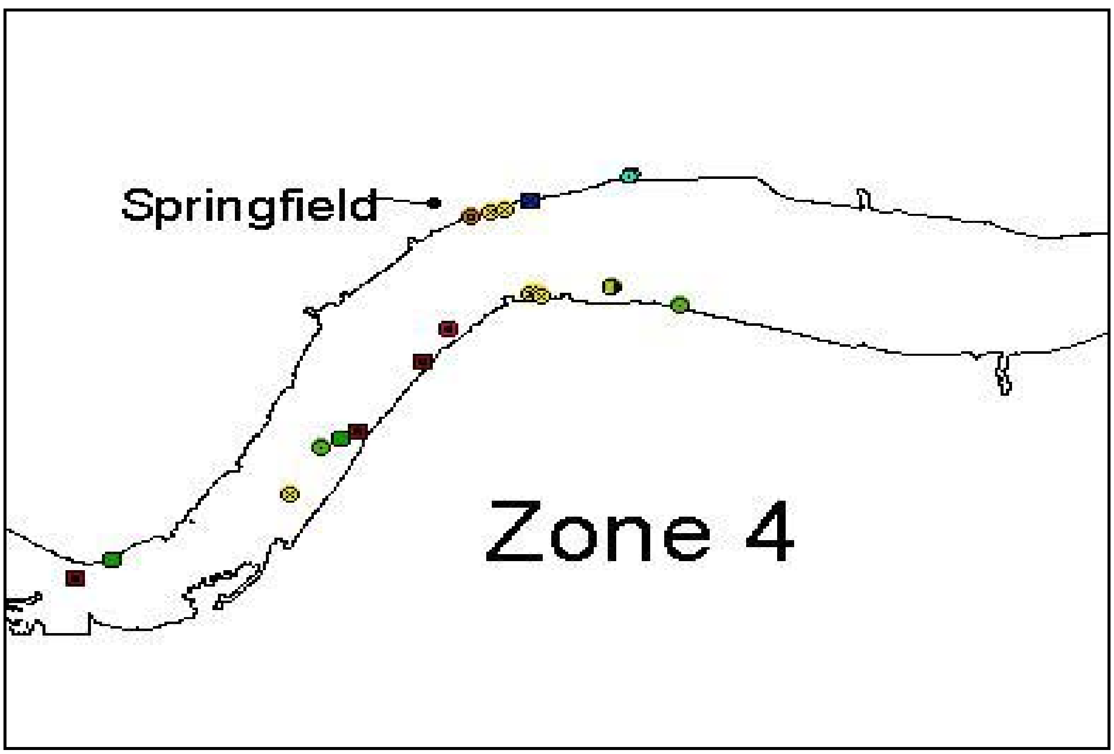

Figure 5. Pallid sturgeon relocation sites in zone 2, Lewis and Clark Lake, SD during 1992.

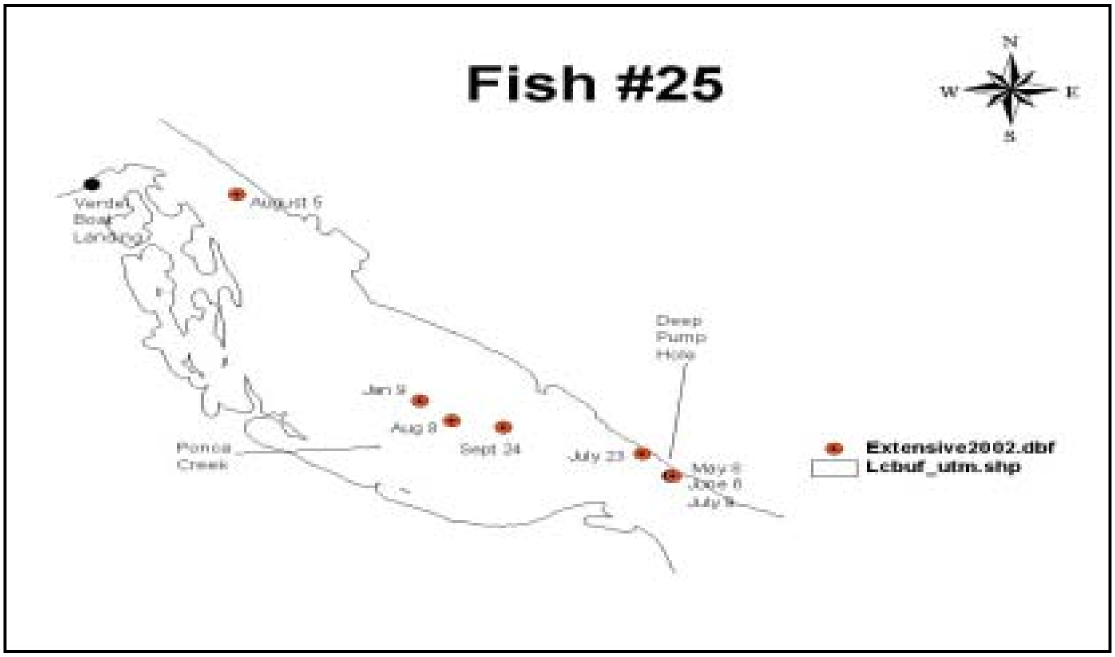

Figure 6. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992.

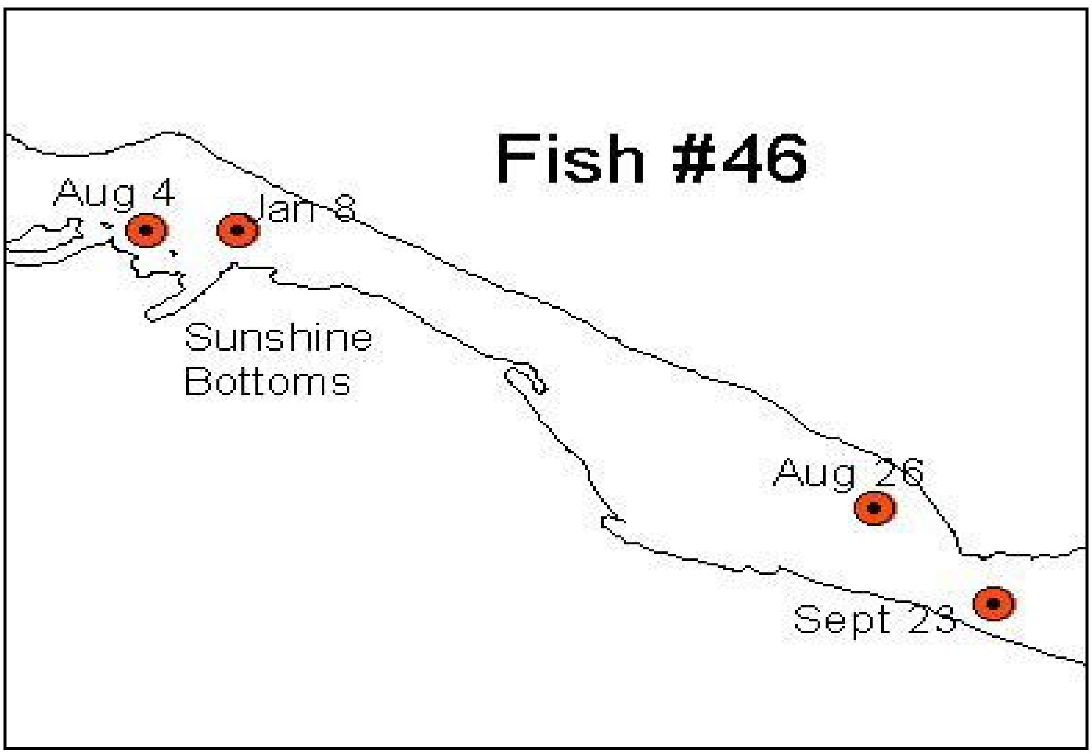

Figure 7. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992.

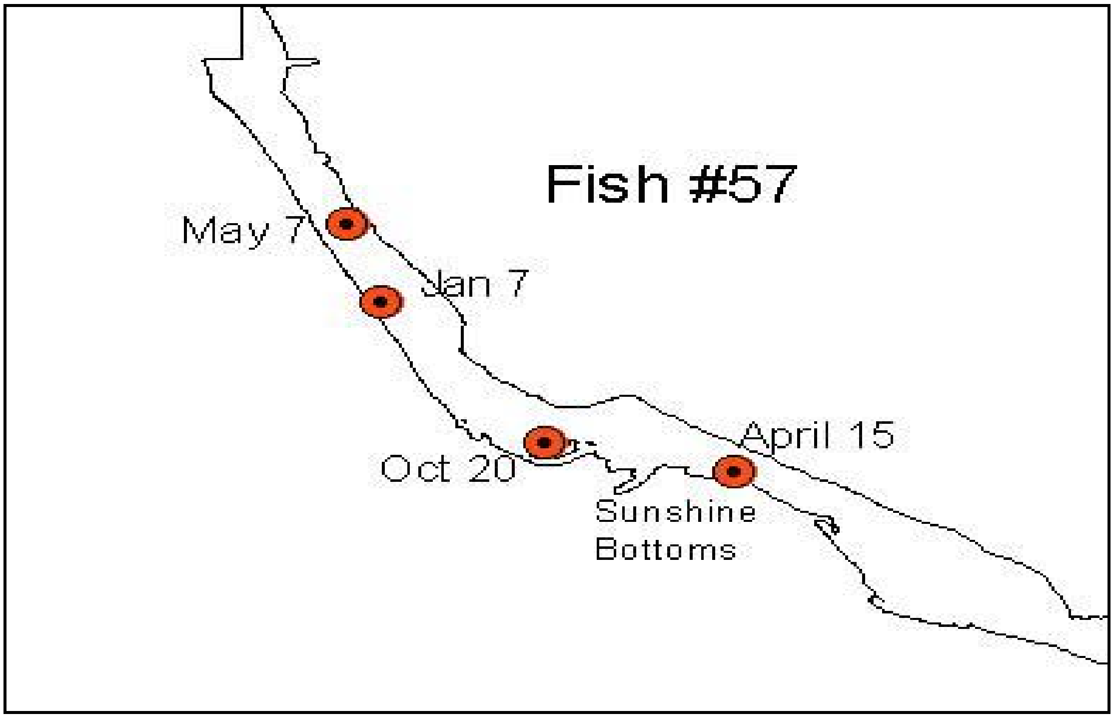

Figure 8. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992.

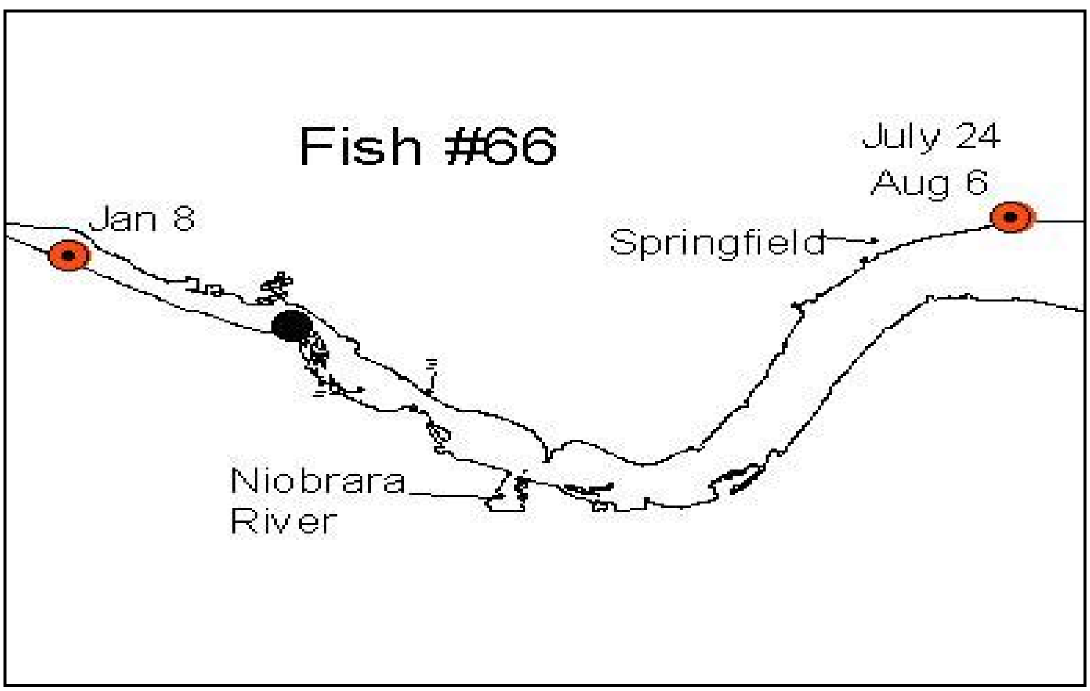

Figure 9. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992.

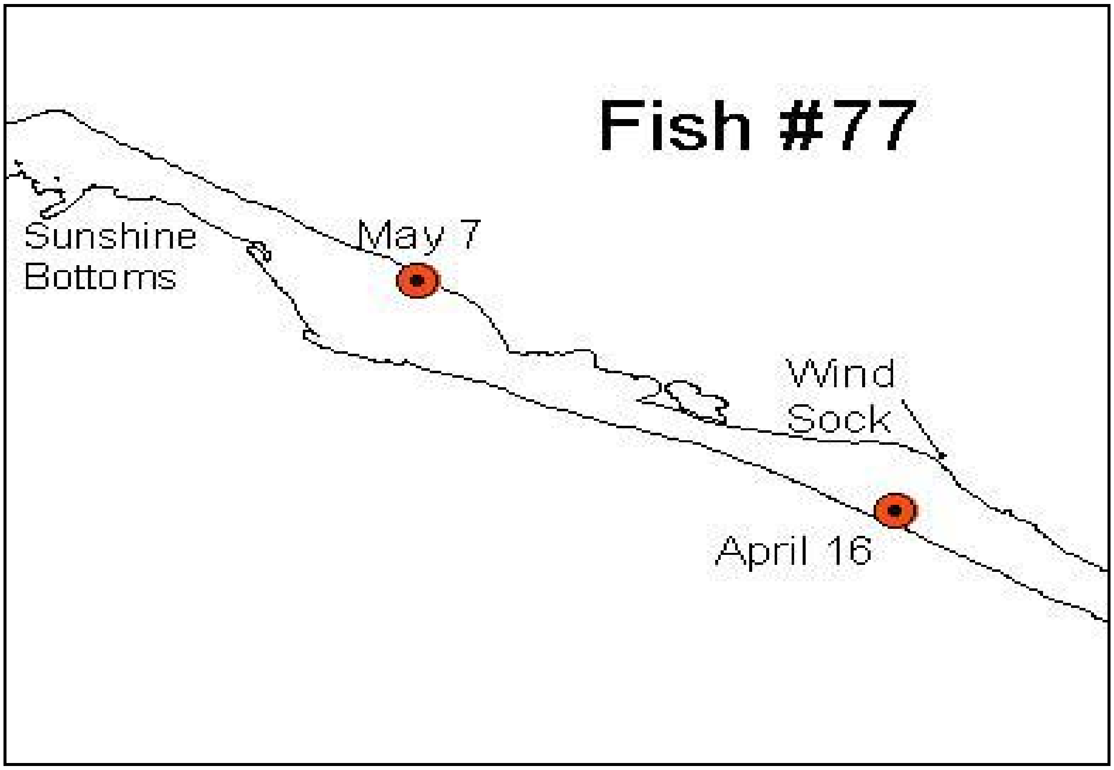

Figure 10. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

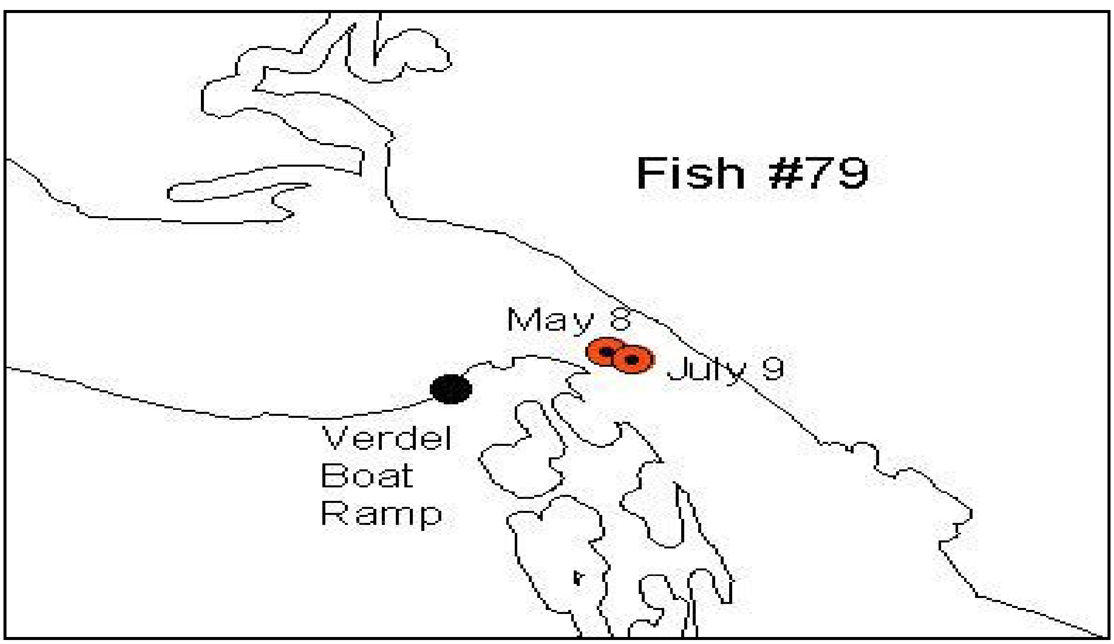

Figure 11. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

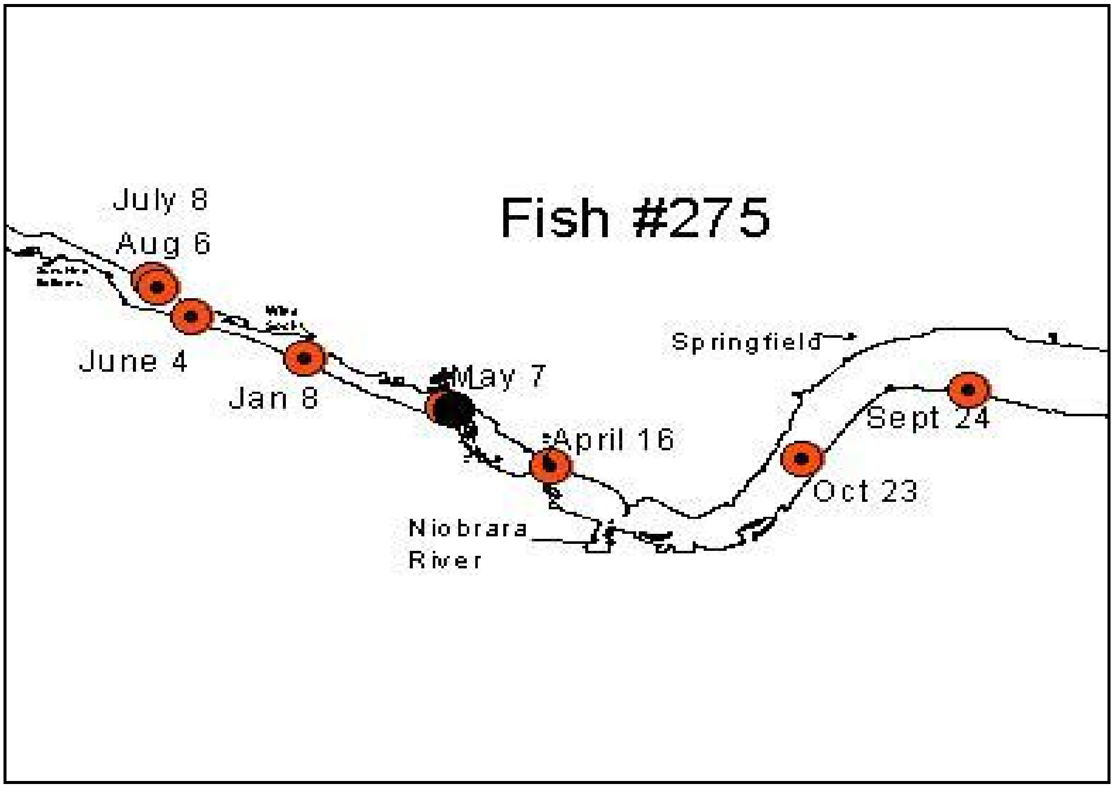

Figure 12. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

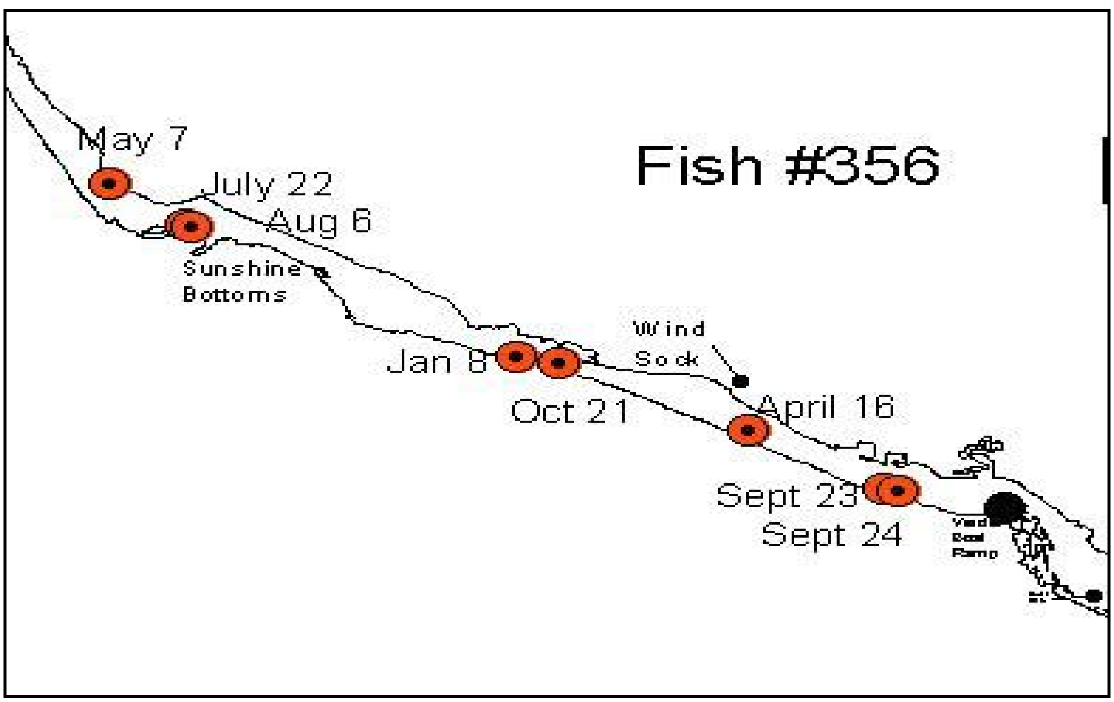

Figure 13. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

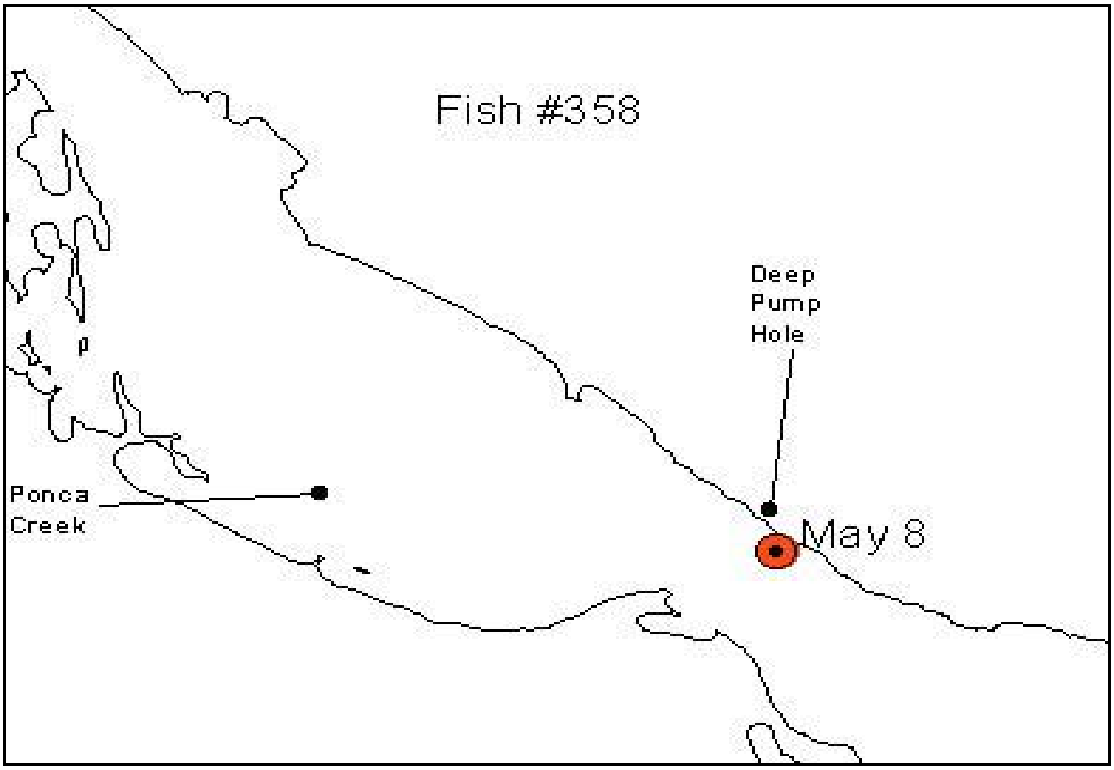

Figure 14. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

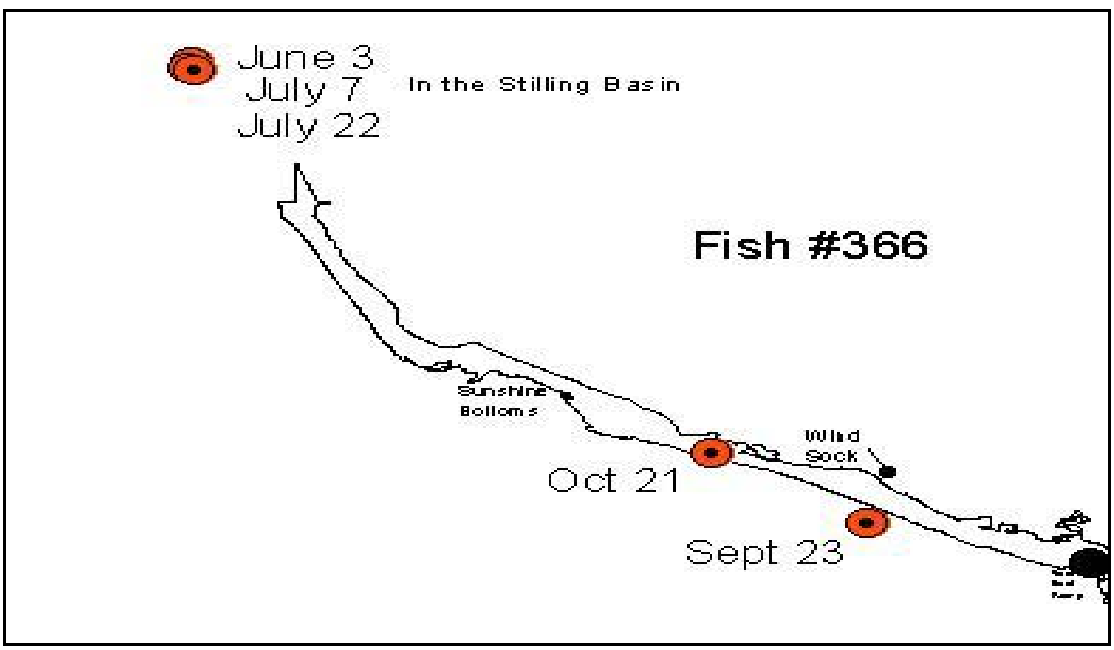

Figure 15. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

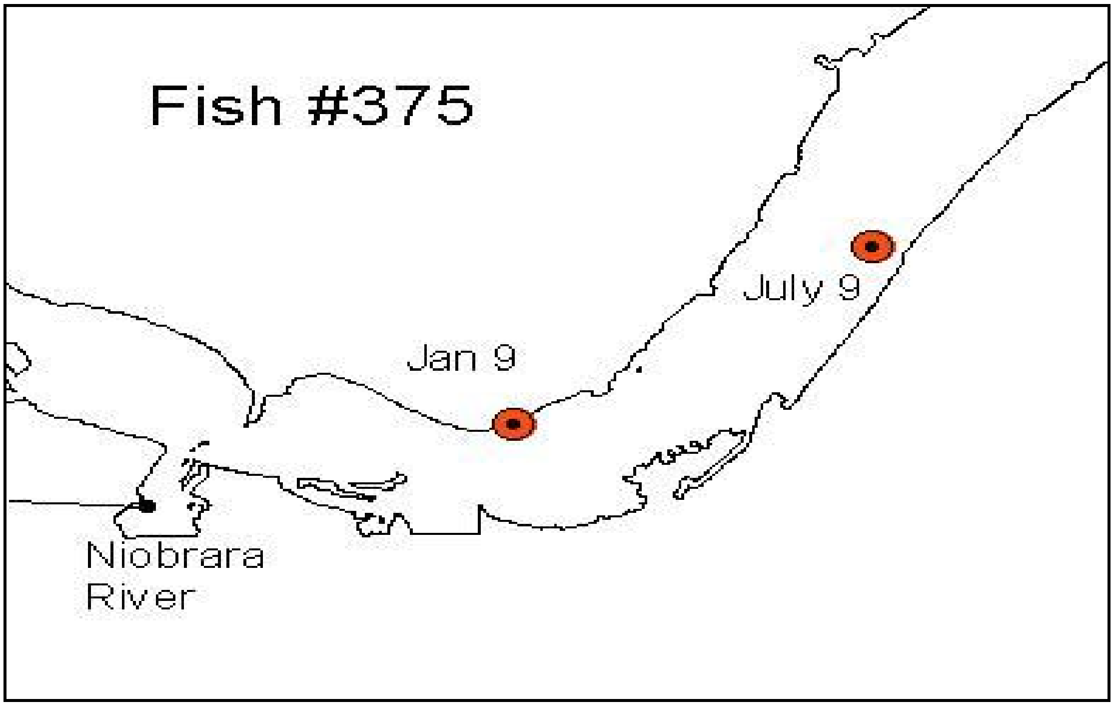

Figure 16. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

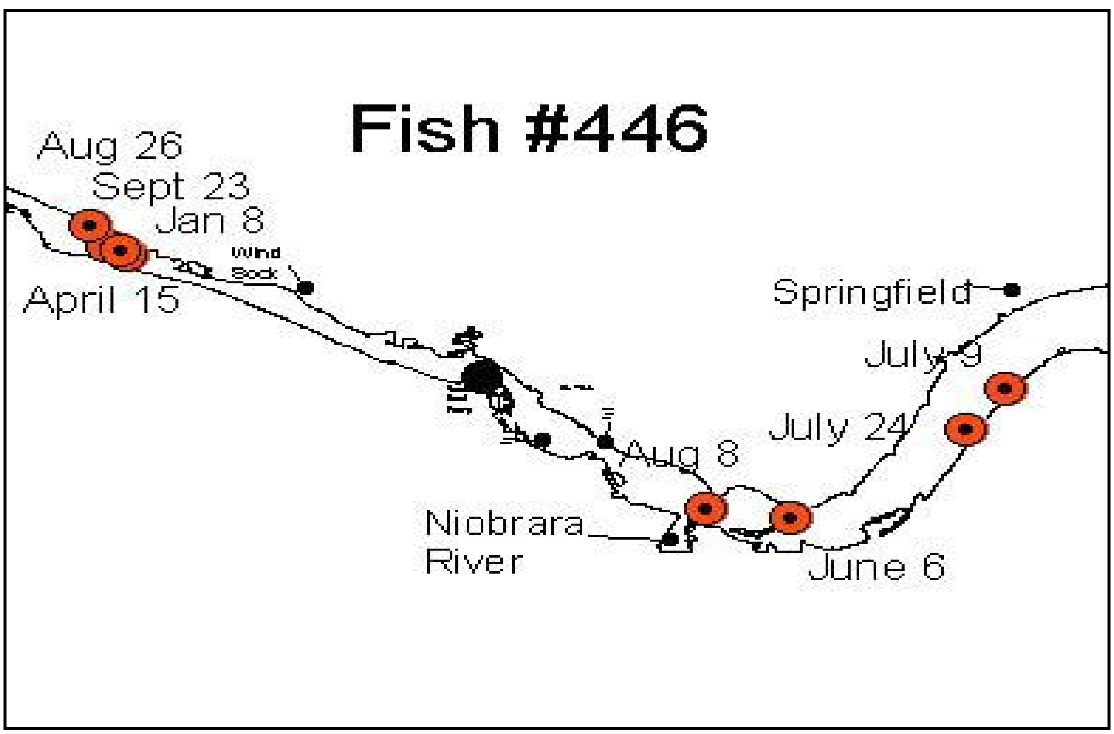

Figure 17. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

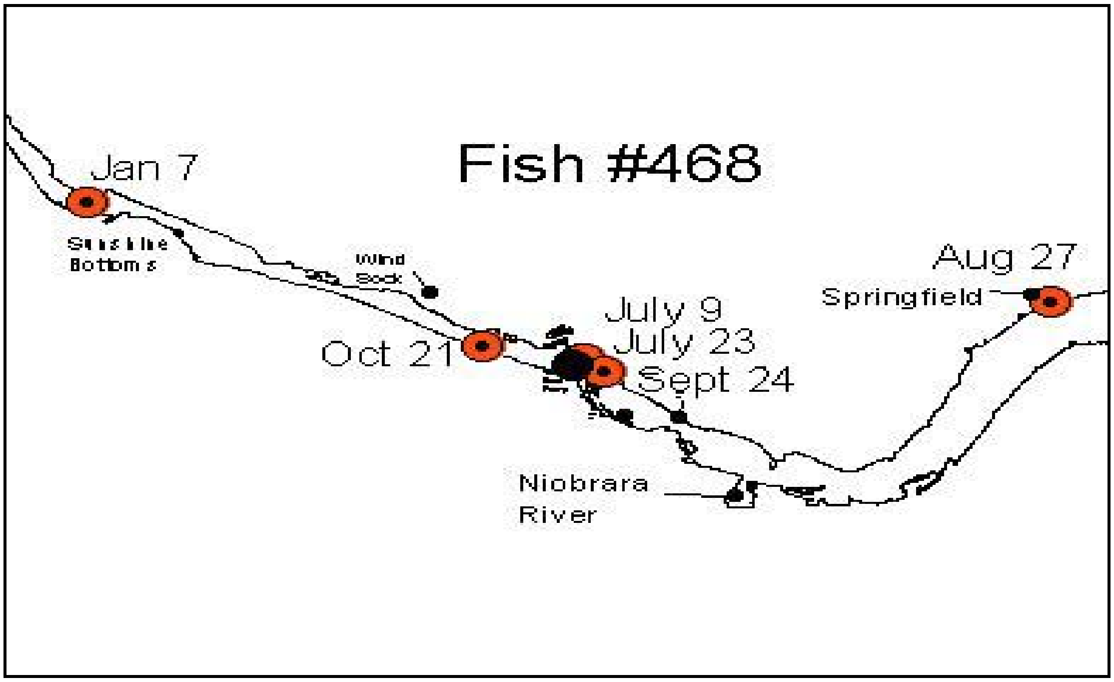

Figure18. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

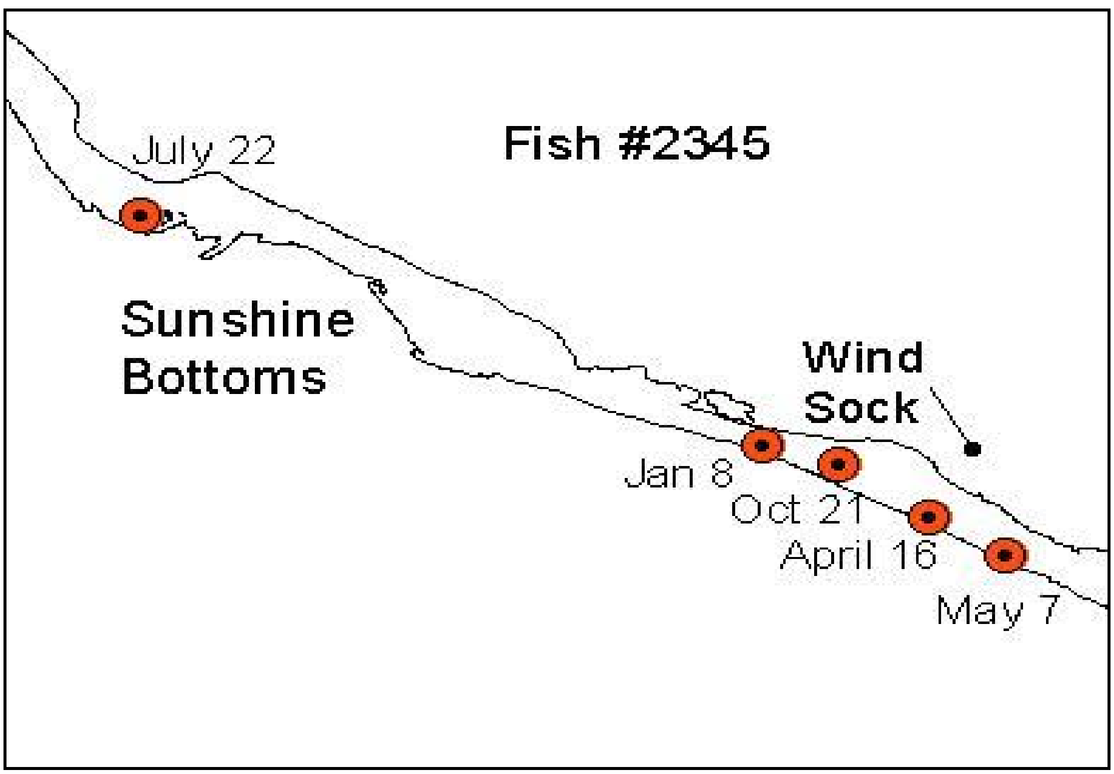

Figure19. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

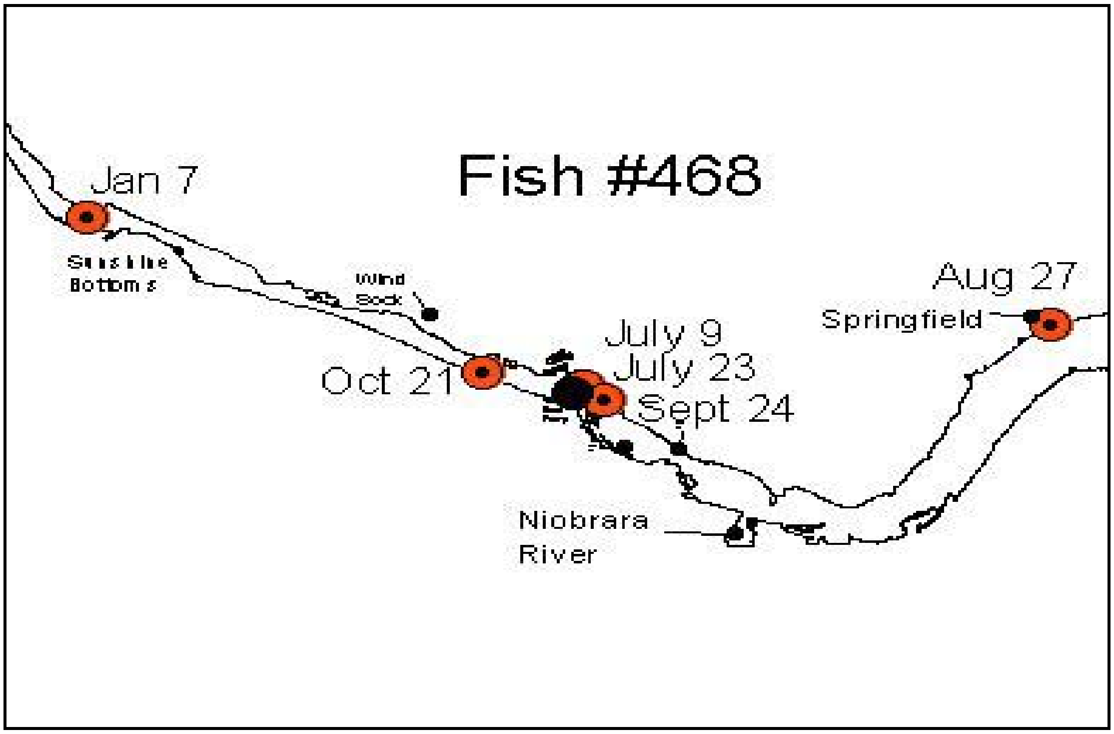

Figure 20. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

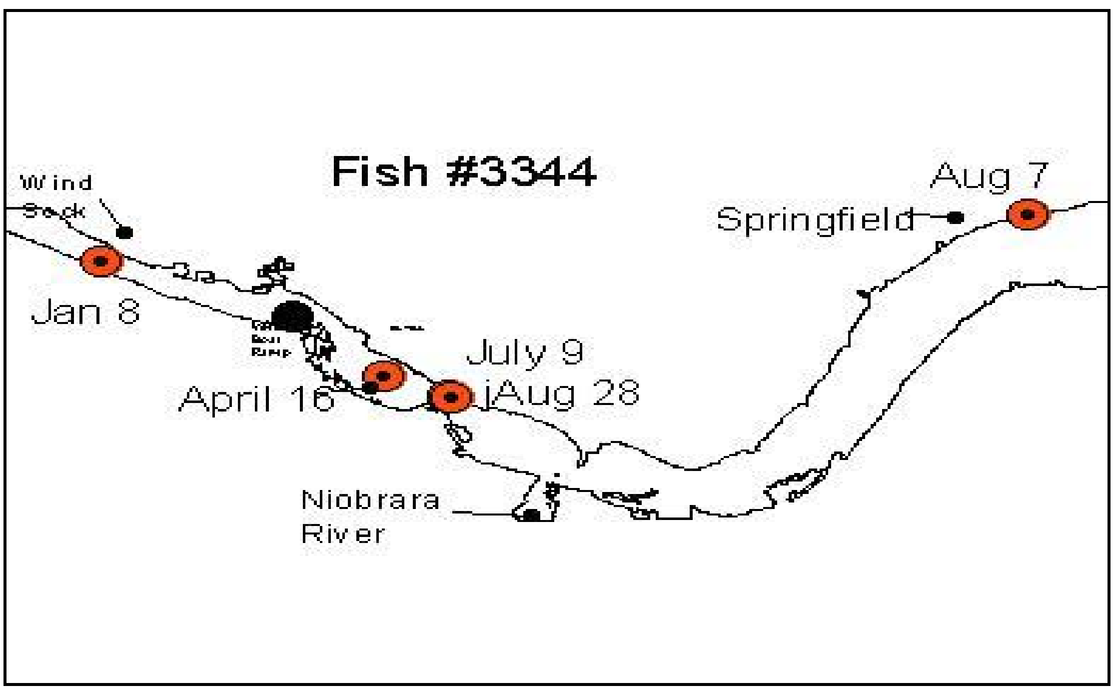

Figure 21. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 199

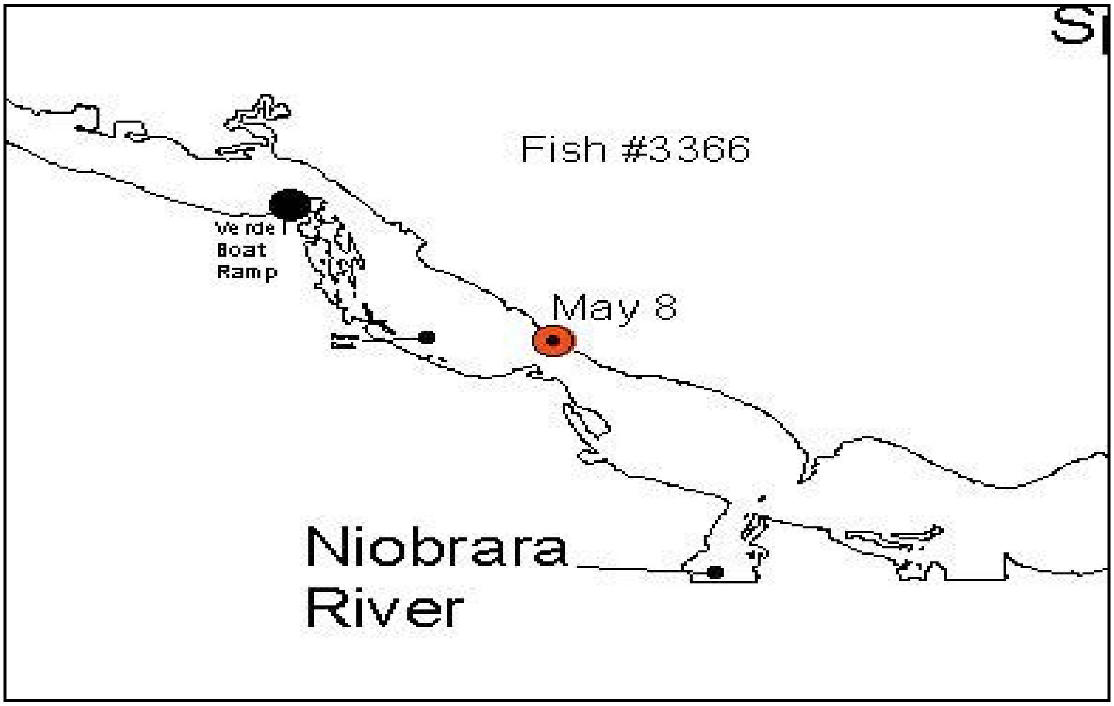

Figure 22. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

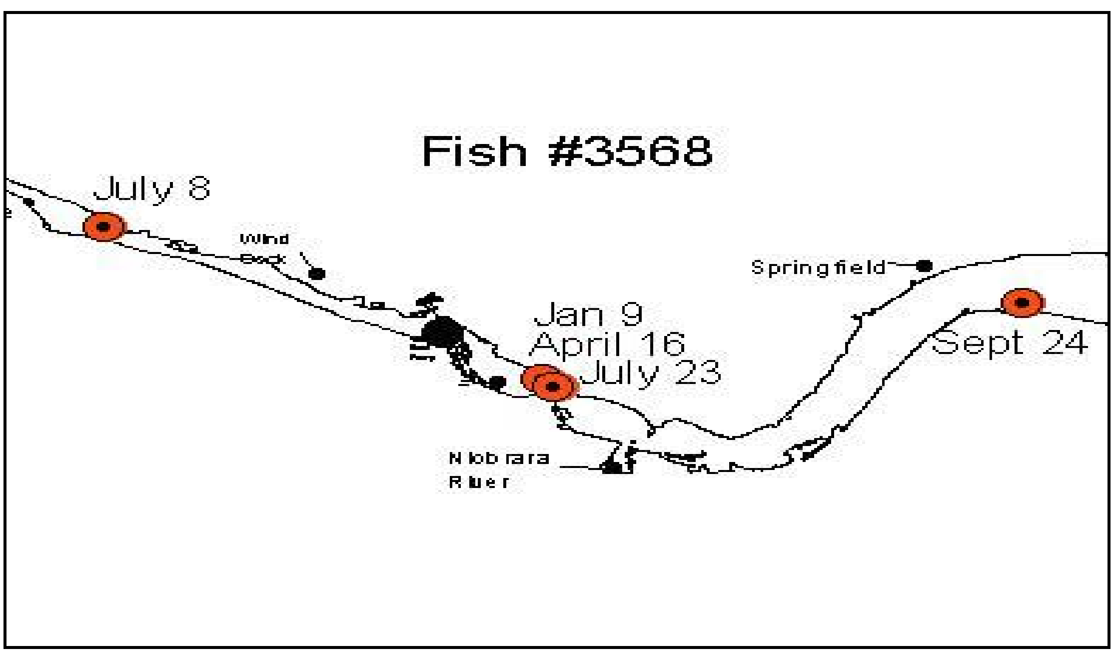

Figure 23. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 1992

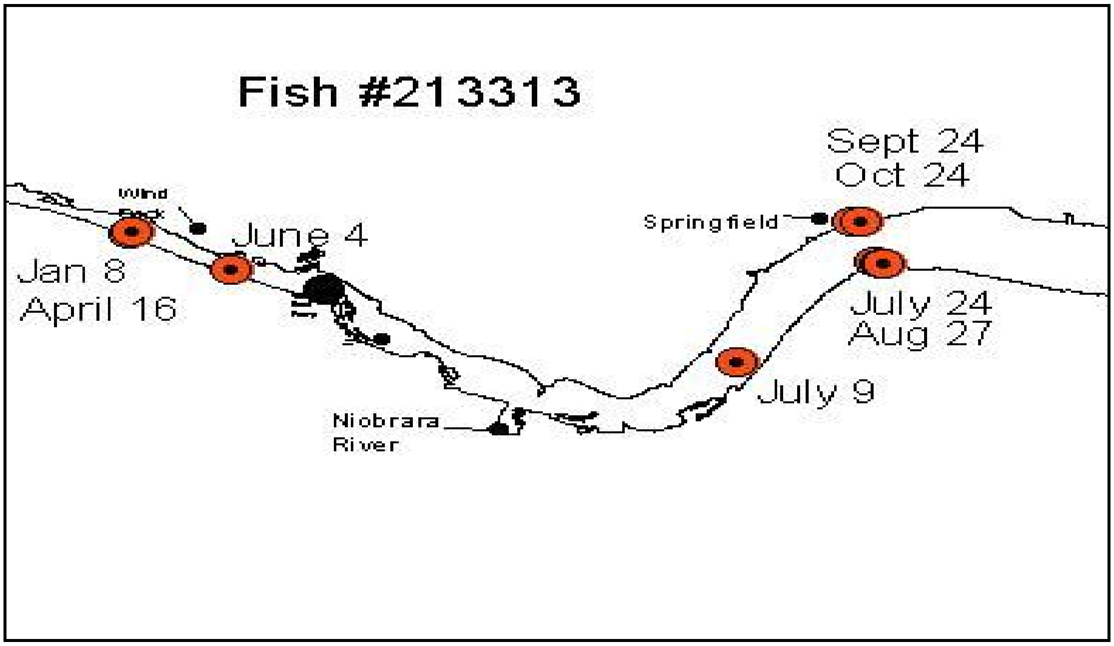

Figure 24. Pallid sturgeon relocation sites in zone 3, Lewis and Clark Lake, SD during 199

2002 Summary Report of Work Conducted by the Missouri River FWMAO on Missouri-Yellowstone River's Pallid Sturgeon

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March 8, 2003

Study Area

Sampling for pallid sturgeons was primarily conducted on the first 20 miles of the Yellowstone River upstream form it's confluence with the Missouri River and the Missouri River from the confluence with the Yellowstone River downstream to Highway 85 Bridge near Williston, North Dakota. The primary purpose for collecting pallid sturgeon for 2002 was again for propagation purposes.

Methods

Previous years reports outline methodology and techniques used for capturing pallid sturgeon.

Results

Most of the field work this past year was directed toward the tracking of telemetered broodstock pallid sturgeon, the tagging of fish for stocking and the capture of broodstock pallid sturgeon for propagation efforts. Crews from Montana Department of Fish, Wildlife and Parks, North Dakota Game and Fish Department and the U.S. Fish and Wildlife Service collaborated on these efforts. Broodstock sturgeon not suitable for spawning were released or returned to the confluence region. Results of the telemetry study will be reported in a separate report specific to that project.

The following information in Tables 1 and 2, summarizes the stocking efforts for pallid sturgeon conducted during 2002. These activities were conducted out of Neosho National Fish Hatchery (NFH), Gavins Point NFH, Garrison Dam NFH, Miles City State Fish Hatchery (SFH) and Bozeman Fish Technology Center (FTC). Considerable coordination and collaboration was involved to make this possible including from the states of Missouri, Nebraska, South Dakota, North Dakota, Iowa, Montana. As well, several federal agencies/ programs were instrumental in making this happen including the Corps of Engineers, Fish and Wildlife Service, Fish Health Centers in Region 3 & 6, and Ecological Services. A total of 13,551 one-year old pallid sturgeon were released in the Missouri and Yellowstone Rivers in 2002. These fish were released in Montana, North Dakota, South Dakota, Nebraska, and Missouri. This has been one of the largest stockings to date. This stocking was comprised of progeny from 16 different families and three different year classes.

In the past dozen years, capturing pallid sturgeon has been sometimes successful and sometimes frustrating. Using data collected during the spring capture period, Table 3 is a summary of the spring's effort and catch rates that were calculated for the last five years of sampling using the modified trammel nets.

2002 Stocking Summary by Family

Female	Male			Female	Male	
411D262C1F	41476A0462			411D262C1F	411D0B4E09	
St. Helena	282	5		Sidney	85	5
Boonville	560	5		Wolf Point	85	5
Mullberry Bend	321	5		Fairview	21	5
Bellevue	580	5		Fred Robinson	44	1
Verdel	70	5		Mouth Of Marias	44	1
Sidney	85	5		Judith Landing	44	1
Culbertson	85	5		Coal Banks	44	1
Wolf Point	85	5			367	
Fairview	85	5				
Intake	84	5		Female	Male	
Fred Robinson	269	1		7F7F06672B	7F7D3C5708	
Mouth Of Marias	96	1		Boonville	116	4
Judith Landing	94	1		Mullberry Bend	144	5
Coal Banks	94	1		Mullberry Bend	92	4
	2790			Bellevue	222	5
				Bellevue	81	4
Female	Male			Verdel	70	5
411D262C1F	1F4A4B5973			Sidney	64	2
Boonville	20	5		Fairview	61	2
Mullberry Bend	28	5		Culbertson	61	2
Bellevue	21	5		Wolf Point	61	2
Verdel	70	5			972	
Sidney	85	5				
Culbertson	85	5		Female	Male	
Wolf Point	85	5		220E345E09	1F4A111C6A	
Fairview	85	5		Boonville	362	5
Intake	13	5		Boonville	219	4
Intake	73	1		Mullberry Bend	210	4
Fred Robinson	222	1		Bellevue	217	4
Mouth Of Marias	94	1		Bellevue	336	5

Judith Landing	87	1		Verdel	70	5
Coal Banks	91	1		Intake	66	2
	1059			Sidney	75	2
				Fairview	75	2
Female	Male			Culbertson	75	2
7F7F06672B	115631222A			Wolf Point	75	2
Boonville	180	5			1780	
Verdel	71	5				
Intake	59	2		Female	Male	
Sidney	59	2		1F4A301354	7F7D291A07	
Fairview	60	2		Ponca State Park	7	3
Culbertson	60	2			7	
Wolf Point	60	2				
	549					
Female	Male			Female	Male	
411D262C1F	17509415139			220E345E09	1F4A27214F	
Boonville	52	5		Boonville	257	5
Mullberry Bend	67	5		Mullberry Bend	341	5
Bellevue	51	5		Bellevue	473	5
Verdel	70	5		Verdel	70	5
Sidney	86	5		Intake	74	2
Culbertson	83	5		Sidney	73	2
Wolf Point	85	5		Fairview	73	2
Fairview	84	5		Culbertson	73	2
Intake	85	1		Wolf Point	73	2
Fred Robinson	267	1			1507	
Mouth Of Marias	94	1				
Judith Landing	91	1		Female	Male	
Coal Banks	94	1		411D262C1F	411DOE2C5F	
	1209			Boonville	558	5
				Bellevue	555	5
Female	Male			Mullberry Bend	558	5
7F7B021573	7F7D441774			Verdel	70	5

Greenwood	67	[3]		Sidney	86	[5]
Ponca State Park	70	[3]		Culbertson	64	[5]
Boonville	57	[3]		Wolf Point	85	[5]
Bellevue	75	[3]		Fairview	85	[5]
	269			Fred Robinson	92	[1]
				Mouth Of Marias	90	[1]
Female	Male			Judith Landing	56	[1]
7F7B021573	7F7F06583D			Coal Banks	51	[1]
Greenwood	50	[3]			2350	
Ponca State Park	40	[3]				
Boonville	48	[3]		Female	Male	
Bellevue	42	[3]		220E345E09	7F7D3C5708	
	180			Boonville	9	[4]
				Boonville	198	[5]
Female	Male				207	
7F7B021573	113719262A					
Greenwood	65	[3]		Female	Male	
Ponca State Park	70	[3]		220E345E09	432C063C4E	
Boonville	60	[3]		Bellevue	12	[4]
Bellevue	70	[3]				
	265			**TOTAL**	**13551**	
Female	Male			[1] Denotes fish stocked from Bozeman FTC		
1F4B246E04	7F7D291A07			[2] Denotes fish stocked from Miles City SFH		
Ponca State Park	28	[3]		[3] Denotes fish stocked from Gavins Point NFH		
				[4] Denotes fish stocked from Neosho NFH		
				[5] Denotes fish stocked from Garrison NFH		

2002 Stocking Summary by Site

Fred Robinson Bridge				Fairview			
Female	Male			Female	Male		
411D262C1F	41476A0462	269	1	411D262C1F	41476A0462	85	5
411D262C1F	17509415139	267	1	411D262C1F	411D0E2C5F	85	5
411D262C1F	411D0B4E09	44	1	411D262C1F	1F4A4B5973	85	5
411D262C1F	1F4A4B5973	222	1	411D262C1F	411D0B4E09	21	5
411D262C1F	411D0E2C5F	92	1	411D262C1F	17509415139	84	5
		894		220E345E09	1F4A111C6A	75	2
				220E345E09	1F4A27214F	73	2
Mouth Of Marias				7F7F06672B	7F7D3C5708	61	2
Female	Male			7F7F06672B	115631222A	60	2
411D262C1F	41476A0462	96	1			629	
411D262C1F	17509415139	94	1				
411D262C1F	411D0B4E09	44	1	Sidney			
411D262C1F	1F4A4B5973	94	1	Female	Male		
411D262C1F	411D0E2C5F	90	1	411D262C1F	41476A0462	85	5
		418		411D262C1F	411D0E2C5F	86	5
				411D262C1F	1F4A4B5973	85	5
Judith Landing				411D262C1F	411D0B4E09	85	5
Female	Male			411D262C1F	17509415139	86	5
411D262C1F	41476A0462	94	1	220E345E09	1F4A111C6A	75	2
411D262C1F	17509415139	91	1	220E345E09	1F4A27214F	73	2
411D262C1F	411D0B4E09	44	1	7F7F06672B	7F7D3C5708	64	2
411D262C1F	1F4A4B5973	87	1	7F7F06672B	115631222A	59	2
411D262C1F	411D0E2C5F	56	1			698	
		372					
				Culbertson			
Coal Banks				Female	Male		
Female	Male			411D262C1F	1F4A4B5973	85	5
411D262C1F	41476A0462	94	1	411D262C1F	41476A0462	85	5
411D262C1F	17509415139	94	1	411D262C1F	411D0E2C5F	64	5
411D262C1F	411D0B4E09	44	1	411D262C1F	17509415139	83	5
411D262C1F	1F4A4B5973	91	1	220E345E09	1F4A111C6A	75	2
411D262C1F	411D0E2C5F	51	1	220E345E09	1F4A27214F	73	2

		374		7F7F06672B	7F7D3C5708	61	2
				7F7F06672B	115631222A	60	2
Intake						586	
Female	Male						
411D262C1F	17509415139	85	1	Wolf Point			
411D262C1F	1F4A4B5973	73	1	Female	Male		
411D262C1F	41476A0462	84	5	411D262C1F	41476A0462	85	5
411D262C1F	1F4A4B5973	13	5	411D262C1F	411D0E2C5F	85	5
220E345E09	1F4A111C6A	66	2	411D262C1F	1F4A4B5973	85	5
220E345E09	1F4A27214F	74	2	411D262C1F	411D0B4E09	85	5
7F7F06672B	115631222A	59	2	411D262C1F	17509415139	85	5
		454		220E345E09	1F4A111C6A	75	2
				220E345E09	1F4A27214F	73	2
				7F7F06672B	7F7D3C5708	61	2
				7F7F06672B	115631222A	60	2
						694	
Greenwood					Mullberry Bend		
Female	Male			Female	Male		
7F7B021573	113719262A	65	3	411D262C1F	41476A0462	321	5
7F7B021573	7F7D441774	67	3	411D262C1F	17509415139	67	5
7F7B021573	7F7F06583D	50	3	411D262C1F	1F4A4B5973	28	5
		182		411D262C1F	411D0E2C5F	558	5
				7F7F06672B	7F7D3C5708	144	5
Verdel				7F7F06672B	7F7D3C5708	92	4
Female	Male			220E345E09	1F4A27214F	341	5
411D262C1F	411D0E2C5F	70	5	220E345E09	1F4A111C6A	210	4
411D262C1F	1F4A4B5973	70	5			1761	
411D262C1F	17509415139	70	5				
411D262C1F	41476A0462	70	5	Bellevue			
7F7F06672B	7F7D3C5708	70	5	Female	Male		
7F7F06672B	115631222A	71	5	411D262C1F	41476A0462	580	5
220E345E09	1F4A27214F	70	5	411D262C1F	1FA44B5973	21	5
220E345E09	1F4A111C6A	70	5	411D262C1F	17509415139	51	5
		561		411D262C1F	411DOE2C5F	555	5
				7F7F06672B	7F7D3C5708	81	4

St. Helena			
Female	Male		
411D262C1F	41476A0462	282	5
Boonville			
Female	Male		
411D262C1F	41476A0462	560	5
411D262C1F	1F4A4B5973	20	5
411D262C1F	411DOE2C5F	558	5
411D262C1F	17509415139	52	5
7F7F06672B	115631222A	180	5
7F7F06672B	7F7D3C5708	116	4
220E345E09	7F7D3C5708	198	5
220E345E09	1F4A111C6A	362	5
220E345E09	1F4A111C6A	219	4
220E345E09	1F4A27214F	257	5
220E345E09	7F7D3C5708	9	4
7F7B021573	7F7F06583D	48	3
7F7B021573	7F7D441774	57	3
7F7B021573	113719262A	60	3
		2696	

7F7F06672B	7F7D3C5708	222	5
220E345E09	1F4A111C6A	217	4
220E345E09	1F4A111C6A	336	5
220E345E09	1F4A27214F	473	5
220E345E09	432C063C4E	12	4
7F7B021573	7F7D441774	75	3
7F7B021573	113719262A	70	3
7F7B021573	7F7F06583D	42	3
		2735	
Ponca State Park			
Female	Male		
1F4B246E04	7F7D291A07	28	3
1F4A301354	7F7D291A07	7	3
7F7B021573	113719262A	70	3
7F7B021573	7F7D441774	70	3
7F7B021573	7F7F06583D	40	3
		215	
	RPMA #1	2058	
	RPMA #2	3061	
	RPMA #3	1025	
	RPMA #4	7406	
	TOTAL	**13551**	

[1] Denotes fish stocked from Bozeman FTC
[2] Denotes fish stocked from Miles City SFH
[3] Denotes fish stocked from Gavins Point NFH
[4] Denotes fish stocked from Neosho NFH
[5] Denotes fish stocked from Garrison NFH

Table 2. Summary of pallid sturgeon juveniles stocked in 2002 by site.

Pallid sturgeon effort and catch rates from 1998 through 2002.					
	1998(spring)	**1999(spring)**	**2000(spring)**	**2001(spring)**	**2002 (spring)**
Catch by amount of time drifting	1 pls/96 minutes	1 pls/ 147 minutes	1 pls/ 36 minutes	1 pls/ 52 minutes	1 pls/ 75 minutes
Catch by # drifts	1 pls/39 drifts	1 pls/17.5 drifts	1 pls/4.8 drifts	1 pls/7.6 drifts	1 pls/8.2 drifts
Average drift time	7:02 minutes	8:25 minutes	7:34 minutes	6:50 minutes	9:06 minutes
Number of pallids captured	4	4	9	7	10
# of drifts	157	70	43	53	82
Total amount of time drifting nets	6:25:24	9:49:41	5:25:05	6:02:25	12:32:59
CPUE	.62 pls/1 hour drifting	0.41 pls/1 hour drifting	1.66 pls/1 hour drifting	1.16 pls/ 1 hour drifting	0.80 pls/ 1 hour drifting
FLOW*	16690-20530 17814 avg	18740-19350 18930 avg	11860-12580 12158 avg	10720-11130 10925 avg	9690-12530 10596 avg
Dates	April 14 - 28	April 12 - 15	April 11 - 18	April 24 - 26	April 22 - May 1

* Calculated from combining the Culbertson and Sidney gauging stations recordings for the period of time during sampling.

Table 3. Calculated effort and catch rates for pallid sturgeon captured by this office from 1998 through 2002.

PIT/Tag Number	Year	Length	Weight	Sex	Age
K10	1990	NA	NA	F	31-36
411D235B0E	2000	1358	20384	F	35-46
PLS	1988	1397	10433	M	35-39
220F0F6213	2000	1425	20430	F	33-36
4310187B69*	2002	1435	16798	M	
7F7F06672B*	2001	1435	21942	F	
1F4772396F*	2002	1450	24062	M	
7F7F056171*	1998	1465	29483	F	
132319571A*	2002	1496	21792	F	
PLS	1975	1524	18597		32-35
PLS	1983	1543	17100	F	41
115544332A*	2002	1594	24970	F	
1F54756038/1F5420727B*	2002	1599	30191	F	
7F7F065E12	1998	1600	29483	F	55
1F4B237A79/1F497F6534*	1997	1642	29964	F	

* Ages on these fish will be completed in 2003.

Table 4. Pallid sturgeon ages from mortalities collected from Montana, North Dakota and South Dakota.

Discussion

This year's recovery efforts, although successful in terms of re-starting the collaborative stocking effort, was not without the price that was paid for three years of not fully implementing the stocking plan for pallid sturgeon. The data that was lost from not having progeny in the wild to evaluate the stocking effort is overshadowed by the lack of pallid sturgeon progeny in wild habitats that could have contributed to the future population.

In addition, the moratorium of not being able to bring pallid sturgeon progeny from downstream of Ft. Peck Dam, has resulted in a increase in the likelihood that the population will continue to decline for Recovery Priority Area #1. Although warranted in 1999 when the shovelnose sturgeon virus was first diagnosed, the continued exclusion of valuable progeny that will be critical for rebuilding the population from this area, will likely decrease the success of the overall recovery program for the Upper Basin.

The success of capturing broodstock has been evident in the last five years. In almost every instance, the number of fish needed for the propagation program, were captured. However, successful spawning still remains inconsistent at some facilities. Even if successful spawning is achieved, it is still sometimes difficult to keep mortality of the broodstock to a minimum. Getting the broodstock back into the wild population not only increases the likelihood that they'll be around for use later in the propagation program, but keeping the remaining adults viable increases the chance they will be around to take advantage of future habitat improvements. The numbers of wild broodstock will decrease and the time will come in the next 10 years where efforts will need to be substantially increased to find adequate broodstock for spawning, if they can be found. Efforts need to continue to evaluate techniques used in the culturing of the pallid sturgeon and the best information needs to be used to insure success of this aspect of the recovery program.

Future Recommendations

- Re-evaluate the risks of not maximizing the use of progeny from below Ft. Peck Dam for stocking in all Recovery Priority Areas in the Upper Basin.

- Concentrate collection of broodstock during the fall prior to spawning, using spring captures only when necessary.

  Using this procedure increases our likelihood of having a successful propagation by banking fish early in order to facilitate planning and reduces the amount of stress to the fish. Research and results to date would suggest that holding these adult fish over winter prior to spawning decreases the amount of stress during the spawning by separating two major stressors (capture and spawning) and does not have an adverse affect to propagation efforts.

- Continue augmentation program of pallid sturgeon and intensify monitoring of juvenile pallid sturgeon populations in their habitats.
- Ensure that all facilities that hold pallid sturgeon have adequate capability to keep densities low and conditions favorable for culturing pallid sturgeon to decrease likelihood of diseases and stress.
- Develop/utilize facilities to retain a secondary source of pallid sturgeon progeny as a backup source for stocking purposes.

  Culturing the pallid sturgeon progeny at one facility, could allow a catastrophic event to eliminate that year's work. The main goal would be to culture excess pallid sturgeon at a second facility that would serve as a reservoir in the event that the primary source of pallid sturgeon broodstock would be lost or unsuitable for stocking purposes. Ultimate stocking numbers and hatchery capacity will likely dictate whether this is feasible.

- Continue to improve sampling efficiency of juvenile sturgeon.

- Continue to increase efforts to develop fish by-pass on low-head dams on Yellowstone River and the tributaries to allow fish passage by pallid and shovelnose sturgeon to utilize the middle Yellowstone River for spawning purposes, as well, modify water intakes to reduce potential impacts by entrainment.

- Evaluate stream-side modifications (rip-rap, weirs) and the impacts they may have on various in-channel habitats, especially habitat diversity.

Corps of Engineers Pallid Sturgeon Activities in 2002

The U.S. Army Corps of Engineers (Corps) pallid sturgeon program conducted sturgeon activities in FY 2002. The Corps provided assistance for pallid sturgeon activities targeting two Reasonable and Prudent Alternative (RPA) Elements identified within the 2000 Missouri River Biological Opinion (Opinion). RPA element VI A: Pallid Sturgeon Propagation and RPA element VIB: Pallid Sturgeon Population Assessment. Corps sponsored pallid sturgeon activities for the Missouri River from Fort Peck Dam to the mouth near St. Louis (Corps-Omaha and Kansas City Districts), Missouri are coordinated through the Threatened and Endangered Species Section located at the Gavins Point Project within the Corps of Engineers Omaha District.

Additional studies/research projects are being conducted with Corps support that fall outside of these two elements. These specific studies have been identified as focused research and have been incorporated into a separate section.

Pallid Sturgeon Propagation

The Corps provided support for pallid sturgeon propagation at 6 hatcheries in 2002. Four of these facilities are operated by the USFWS: The Bozeman Fish Technology Center, Garrison Dam National Fish Hatchery (NFH), Gavins Point NFH and Neosho NFH. The remaining two facilities are state operated facilities: The Miles City State Fish Hatchery (Montana Fish Wildlife and Parks) and the Blind Pony State Fish Hatchery (Missouri Department of Conservation).

In March, the hatchery managers of these facilities, as well as USFWS and Corps representative met in Yankton, South Dakota to develop the components of a pallid sturgeon propagation plan. This group (Propagation Workgroup) served several functions: identified the hatcheries to be included in the plan, identified production capacities/capabilities for each hatchery, and identified fish health requirements for stocking fish. Additional information such as Effective Population Size for the each Recovery Priority Management Area was reviewed. This information was compiled into a Pallid Sturgeon Propagation Plan for the Missouri River System. This group also provided priority rankings for disbursement of available funding.

Support for propagation activities in FY 2002 totaled $187,800. Additionally, the Corps assisted with tagging and stocking activities. In August, additional "end-of-year" money was acquired targeting the propagation program. The focus for these funds was to increase production capabilities providing long-term benefits to the propagation program. The propagation workgroup compiled and prioritized a list of items for each hatchery. These items were prioritized based on: 1) increasing production capabilities 2) improving water supply quantity and/or quality 3) enhancing cryopreservation capabilities throughout the Missouri River system 4) improving feed storage to ensure quality nutrition 5) a variety of miscellaneous items (PIT Tags, broodstock trailer, etc.). This priority ranked list was funded in its entirety ($452,795). This support provides long-term benefits targeting the "Average Annual Shortfall" identified within the Opinion. The cumulative support for propagation in FY 2002 totaled $640,457.

Highlight of Propagation Activities in 2002

- In April, 2002, pallid sturgeon were stocked into the lower Missouri River (below Gavins Point Dam) from parentage originating in the "Upper Basin".

Pallid Sturgeon Population Assessment

Corps supported pallid sturgeon and fish community assessment included sampling by the Nebraska Game and Parks Commission in river segments 8-13 (as identified in the Opinion). The U.S. Fish and Wildlife Service (USFWS), Columbia Fishery Resource Office also conducted pallid sturgeon and fish community assessment sampling in river segments 14 and 15 (as identified in the Opinion). A group of fishery biologists representing State and Federal Agencies from Montana to Missouri are working together along with the Corps to develop a standardized plan to conduct pallid sturgeon and fish community sampling for the Missouri River system. Identified within the Opinion, the Corps has the responsibility of developing and implementing a pallid sturgeon population assessment plan for the priority river segments of the Missouri River. This plan will include "Standard Operating Procedures" (SOPs) such as habitat classification, gear types, techniques for deployment, physical habitat characteristic data collection, etc. Current sampling is conducted in accordance with existing "draft" plans.

Highlight of Population Assessment Activities in 2002

- Several hatchery reared juveniles were collected by crews during population assessment sampling

Focused Research

Additional studies above and beyond pallid sturgeon population assessment were conducted in FY 2002. In the Fort Peck reach, The Fort Peck Flow Modification Study (USGS/MTFWP) and the telemetry study (USFWS), "Movements and Habitat Preferences of Adult Post Spawn Pallid Sturgeon of Known Gender" continued throughout 2002. In conjunction with spring sampling/broodstock collection, USGS conducted side scan sonar and utilized an ultrasound to identify sex of adult pallid sturgeon. In the Fort Randall reach, the telemetry study of juvenile and adult pallid sturgeon, "Pallid Sturgeon Assessments Recovery Priority Management Area III Lewis and Clark Lake, South Dakota and Nebraska (USFWS). This telemetry project was complimented by an additional study, "Pallid Sturgeon Habitat Assessment in the Niobrara Reach of the Missouri River" (USGS). This study consisted of a qualitative and quantitative assessment of depth, substrate, velocity and imagery in conjunction with known locations of pallid sturgeon. Total support for these studies was $365,000.

Bureau of Reclamation

Intake – looking at passage and correction of entrainment

Recently completed a value engineering study – several alternatives have been identified that involve replacing the dam, screening, etc. Irrigation company has supported alternative #1 (Overmeyer Dam). USFWS prefers that.   Funding will be dependent on Congressional approval. BOR will come out with a revised BA with information in it re: alternatives.

FYI – title transfers to non-government entities is nondiscretionary, meaning they won't consult with the FWS on any. If any concerns about continuing, ongoing operations, write to BOR so it can be covered before a title transfer

FISH HEALTH AND PROPAGATION

Bozeman Fish Health Center - 2002/2003 Sturgeon Fish Health Summary. Crystal Hudson, U.S. Fish and Wildlife Service, Fish Health Center, Bozeman, Montana

Bozeman Fish Technology Center Diet Development and Propagation Activities Report for 2002.

Miles City State Fish Hatchery Summary, October 1, 2001 - September 30-2002
Mike Rhodes, Montana Fish, Wildlife and Parks, Miles City State Fish Hatchery, Miles City, Montana.

Pallid Sturgeon Propagation –2002 - Garrison Dam NFH. Rob Holm, U.S. Fish and Wildlife Service, Garrison Dam NFH, Riverdale ND

Fiscal Year 2002 Sturgeon Activities and Accomplishments. Herb Bollig, Gvins Point National Fish Hatchery, 31227 436th Avenue, Yankton, South Dakota 57078-6364

BOZEMAN FISH HEALTH CENTER
2002/2003 STURGEON FISH HEALTH SUMMARY

Throughout the 2002 season, numerous sturgeon samples were submitted to the Bozeman Fish Health Center for general health assessment and iridovirus screening. Pallid, shovelnose and lake sturgeon were evaluated from several federal, state, and commercial programs including:

***Hatcheries**:* Garrison Dam NFH, Gavins Point NFH, Private John Allen NFH, Mammoth Springs NFH, Neosho NFH, Natchitoches NFH, Bozeman Fish Technology Center, Miles City SFH, Blind Pony SFH, Wild Rose SFH, Rainy River First Nations Hatchery (Canada), The Tennessee Aquarium.

***Free-Ranging Sturgeon**:* Missouri River, Yellowstone River, Wisconsin and Wolf Rivers, French Broad River (Tennessee).

A total of 1,062 cultured and free-ranging sturgeon were examined at the Bozeman Fish Health Center from Oct., 2001- Mar., 2003. These samples were a combination of lethal and non-lethal collections using histological analysis to assess general fish health or screening for the iridoviral agent.

***Iridovirus Detection**:*
On January 30, 2002: 60 pallid sturgeon were lethally and non-lethally sampled at the Gavins Point National Fish Hatchery. Several year classes were tested and screened for the iridoviral agent. The 1998 year class tested positive for the viral pathogen.

Pallid sturgeon juveniles were examined on February 5, 2002 from the Garrison Dam National Fish Hatchery. Samples were considered suspect for the iridovirus, however, cold water temperatures precluded a definitive diagnosis.

March 20, 2002: The Natchitoches National Fish Hatchery submitted sturgeon hybrids for non-lethal iridoviral screening. The iridovirus was detected in pectoral fin clips by histology.

In June of 2002, the iridoviral agent was detected in pallid sturgeon juveniles at the Miles City State Fish Hatchery.

July 9, 2002: Non-lethal fin clips were submitted from a pallid sturgeon adult female from the Garrison Dam hatchery, which tested positive for the iridovirus.

October 22, 2002: The iridoviral agent was detected in YOY pallid sturgeon from the Gavins Point NFH.

Jan. 27, 2003: YOY pallid sturgeon tested positive for the iridovirus from the Garrison Dam National Fish Hatchery.

***Update on Diagnostic Methods**:*

* The pallid and shovelnose sturgeon iridovirus has not been cultured to date.

* Histology and electron microscopy continue to be the only available confirmatory techniques. Current diagnosis of pallid or shovelnose iridovirus requires observation of pathognomonic cells in tissue sections. With electron microscopy, enlarged cells can be observed with hexagonal, double enveloped virus particles with a condensed bar shaped core.

***DNA-PCR Development**:*

* Iridoviruses have been confirmed in several sturgeon species including:

White Sturgeon
Russian Sturgeon
Pallid Sturgeon
Shovelnose Sturgeon
Italian Sturgeon

* Sturgeon iridoviruses are morphologically similar and exhibit a similar tropism for fin epithelia. In addition, they have similar presenting signs of disease - lethargy, anorexia, and reddened skin lesions primarily on the ventral surface. Disease appears to be most severe in young fish and outbreaks are associated with highly variable rates of mortality.

* Similar characteristics of sturgeon iridoviruses suggest they may be closely related. Based on this assumption, researchers at the University of California at Davis have attempted to develop a genetically based PCR assay with the ability to detect iridoviruses in several sturgeon species.

* The White sturgeon iridovirus (WSIV) has been successfully cultured. It was therefore chosen as a template for PCR development for Russian, pallid and shovelnose sturgeon iridovirus.

* Primers were obtained by cloning and sequencing WSIV genome DNA fragments and selecting a segment that had several regions homologous to other iridovirus major capsid protein sequences.

* Two original primer sets were developed: PCR-1 and PCR-2

PCR-1: detected all WSIV and WSIV-like agents, including Russian (RSIV), and pallid sturgeon (PSIV)

PCR-2: distinguished WSIV from RSIV, but was unable to detect PSIV

* Preliminary PCR results were promising, however subsequent assays suggested the Primers used were not effective for detecting PSIV.

* Histological evaluation was compared to the PCR assay with known PSIV infected samples. The PCR assay failed to consistently detect PSIV in samples which had been confirmed positive with histopathology.

* Current research efforts to develop more sensitive iridovirus detection methods are continuing at UC Davis under the direction of Dr. Ron Hedrick. We recently sent iridovirus positive pallid sturgeon from Garrison Dam NFH to UC Davis for further testing and comparison to WSIV and other sturgeon iridoviruses.

Histology Results (PCR validation):

* The pectoral fin was identified as the tissue containing the highest number of infected cells in iridovirus-positive fish.

* The dorsal fin exhibited the second highest number of infected cells.

* Only when other tissues were heavily infected, were iridovirus cells found in gills.

Sturgeon Liver Health Assessment:

A distinct difference has been noted between the appearance of livers from artificially propagated sturgeon stocks and free-ranging populations. Histological analysis at the cellular level has confirmed fat levels in hatchery reared sturgeon consistently are ranked as +4 and +5 (moderately severe to severe). These levels are considered pathological or detrimental to overall fish health. In contrast, free-ranging sturgeon livers routinely rank as +3 or less (more moderate liver fat content). We believe the liver condition observed in captive sturgeon is not just related to nutritional factors alone. These observations suggest fatty livers are a result of both nutrition and physiological influences. The hatchery environment (ie. circular tanks; cold temperatures; artificial feeds; and minimal physical activity) negatively influence the normal physiological activities of free-ranging sturgeon. The captive environment provides minimal opportunities for normal swimming activities and can promote reduced metabolism and accumulation of fat in livers.

Although some of these parameters are inherent within the hatchery environment and cannot be easily altered, every effort should be made to maximize nutritional requirements of captive sturgeon and management of water quality and temperatures to provide an optimal environment for artificial propagation programs.

Bozeman Fish Technology Center
Diet Development and Propagation Activities Report for 2002.

Diet Development

Captive-reared sturgeon fed formulated feeds can exhibit slow growth and curled pectoral fins. These conditions can become very severe in some cases. The condition seems to be a greater problem when well or spring water is used relative to surface waters. Slow growth of sturgeon greater than 16 inches in total length, however, has also been reported using surface water. Comparison of the proximate and mineral composition of pellet fed sturgeon to sturgeon consuming natural feeds revealed some stark differences. The most notable differences were in the macro-minerals, calcium, phosphorus and magnesium. All three of these minerals were found in significantly greater concentrations in the fish consuming the natural feeds. A series of experiments were conducted to determine if fin curling could be prevented and growth rate improved through dietary modification to allow for proper mineral deposition.

The first study involved supplementation of the feed with graded levels of di-calcium phosphate. Five diets were fed to triplicate lots of 50 pallid sturgeon for 16 weeks. The fish averaged 400% increase in weight, but there was no significant difference among treatments. The added calcium and phosphorus to the diet did not increase weight gain. Fin condition was poor at the beginning of the trial so the affect of diet on fin condition could not be measured. Mineral analysis of the fish consuming the supplemented diets at the end of the trial showed no increase in calcium or phosphorus as compared to the fish fed the un-supplemented diet. Measurement of gastric pH showed higher pH values than typically observed with trout even though this species is thought to have an acid stomach. Digestibility of calcium and phosphorus from di-calcium phosphate is dependant upon a low pH environment.

A second study was conducted using sodium phosphate as the phosphorus source with the same experimental design as in the first study. Results from that trial showed a negative response of growth to increasing levels of sodium phosphate. There was a direct negative correlation between sodium phosphate level and dietary pH. As the level of sodium phosphate increased in the diet, the pH of the feed decreased. Although this pH level does not decrease feed consumption of trout it may have affected feed consumption of the sturgeon.

Despite the lack of beneficial effect of dietary modification on macro-mineral absorption, fin condition and weight gain, the difference in these three parameters still exists between wild-reared and captively reared fish. We are currently conducting a third trial in this series investigating the relationship of vitamin D and dietary mineral levels.

PIT tag retention evaluation

We evaluated tag retention in two different size groups of pallid sturgeon fingerlings (excess to stocking needs), 6-7" and 8-9", to determine if smaller fingerlings would retain PIT tags. Stocking fingerlings at a smaller size would reduce chances of fish breaking with disease (shovelnose sturgeon virus) and better accommodate some hatchery rearing programs. To enhance tag retention, it was suggested to apply “super-glue”, gel-type adhesive over the PIT tag needle hole to help retain the tag and enhance healing. The PIT tag was injected in front of the dorsal fin in the dorsal musculature. Fifty fish were tagged in each of the treatment groups (6-7" with glue, 6-7" without glue, 8-9" with glue, and 8-9" without glue). Fifty days after tags were implanted there was little difference in tag retention between the groups. Tag retention in the two groups without glue applied to the hole was 89.3% of the 6-7" fingerlings and 92% of the 8-9" fingerlings. Tag retention in the two groups with glue applied over the hole was 85.7% of the 6-7" fingerlings and 90% of the 8-9" fingerlings.

Propagation

No 2002 pallid sturgeon progeny are being reared at the Bozeman Fish Technology Center. One adult female captured in the Missouri River above Fort Peck Dam, died prior to spawning. Although eggs were collected from the female after death, no embryonic development was observed in the three lots of eggs that were fertilized. Garrison Dam NFH was able to get approximately 50 progeny to hatch and survive from one of the lots (from the same female) they took to Garrison for backup.

Surviving progeny from 2001 spawning were stocked out in July and September 2002 (see Table 1 below). At the end of 2002, we still had 283 fingerlings of family lot no. 139, and 99 fingerlings of family lot no. 462 on station. Study plans for remaining fingerlings include implanting transmitters for telemetry studies in the upper Missouri River and the Yellowstone River above the Intake Diversion structure, and to evaluate gastric lavage techniques for nonlethal collection of stomach contents from juvenile sturgeon to determine food preferences.

Table 1. Pallid sturgeon stocking accomplishments from the U. S. Fish & Wildlife Service Bozeman Fish Technology Center, Montana, to Missouri River locations above Fort Peck Dam and to the Yellowstone River. (Fingerlings released were progeny from 2001 spawning efforts, average length and weight was 280 mm and 50 g).

Stocking Locations (all Montana)	**Stocking Date**	**Pallid Sturgeon Family Lot No.**					**Total no. stocked**
		462	**139**	**973**	**C5F**	**265**	
Missouri River - Fred Robinson Bridge	07/23/02	94	94	95	92	44	**419**
Missouri River - Fred Robinson Bridge*	07/23/02	175	174	127	-	-	**476**
Missouri River - Marias River Confluence	07/24/02	96	94	94	90	44	**418**
Missouri River - Coal Bank Landing	07/24/02	94	94	92	51	44	**375**
Missouri River - Judith Landing	07/24/02	94	94	87	56	44	**375**
Yellowstone River - below Intake Diversion	09/18/02	-	84	71	-	-	**155**
Total from each family lot =		553	634	566	289	176	**2218**

*Fish stocked for experimental take to collect biological information (growth, stomach analysis, proximate analysis, fish health assessment, etc.).

Miles City State Fish Hatchery Summary
October 1, 2001 - September 30-2002

October – December - 2001 - Due to the water temperature and water quality at this facility, the sturgeon were kept at 40-45° and fed #2 silver cup every other day, and not handled.

January – 2002 - Herb Bollig (GPNFH), was here to assist hatchery personnel with the elastomer tagging of the excess sturgeon from each tank. This allowed tagged fish to be combined in another tank and created space in the circular tanks for the production fish.

February – 2002 – During the month of February, 5200 excess pallids were transported to the Gavins Point NFH and given to personnel for the Neosho NFH, who then transported them back to their hatchery in Missouri.

April – 2002 – Personnel from USFWS delivered adult pallids (3 males & 1 female). They were put into 10 foot holding tanks and kept at 52 –55 °. The water temperature on the juvenile pallids has been increased to 58°.

May – 2002 – Hatchery tours consumed this month. One tank of the adults (both males) was uncovered so the visiting public could observe them. (Do these adults need this kind of stress?).

June –2002 - Hatchery personnel cathetorized the lone female once a week starting June 10^{th}. Egg samples were sent to Herb Bollig at GPNFH so that proper staging could be done. During the week of June 24^{th}, Herb was here to stage this female one more time and it was determined that she was ready to ovulate. Each fish (3 males and 1 female) were injected with LHRH hormone. All the sperm was precollected the following day and the female began to shed eggs that night. The female was spawned 7 times over the next 24 hours. Eggs were fertilized with the two known males. The third male (if it truly was a male) was confused with this process and produced no sperm at all. In order to get the third cross some of the eggs were fertilized with milt from a male being held at Garrison NFH. Miles City eggs were split with half going to Garrison. All of this transport was done using Reder's Flying Service and saved many hours of windshield time. We also received approximately 10,000 eggs on June 19^{th} from Garrison. Now the MCFH has 4 different lots. Eggs from the female here at Miles City looked good for the first few days, but the eventual eye up was 0%. What went wrong is anyone's guess.

During the June meeting it was also announced the surplus fish MCFH has been holding had tested positive for irridovirus. These fish had been crowded all along in a separate tank away from the production fish. These fish had a severe gill disease outbreak, which is why we sent the fish in for diagnosis in the first place. Very few fish were left after this and the remaining were sent to U.C. Davis of PCR research.

July – 2002 - Crews from Bismarck USFWS and MT FWP were here to inject pit tags in the production fish.

The only lot of pallid fry (116224546A X 220F107A5F) has been started on feed.

On July 17th, 1277 pallids were released, 199 at Intake, 271 at Sidney, 269 at Fairview, 296 at Culbertson, and 269 at Wolf Point.

September- 2002 - Funding ($173,539) was received from the USCOE for the purchase of a Chiller, a UV system, drum filters, and the plumbing parts needed for installation. All of this will be installed this winter and operational this spring.

Special thanks to all that have assisted the Miles City Hatchery crew in any way.

PALLID STURGEON PROPAGATION -2002
Garrison Dam NFH

Rob Holm

US Fish and Wildlife Service
Garrison Dam NFH, Riverdale ND

Background/Introduction

The Pallid Sturgeon Recovery Plan (1993) established guidance for collection of wild brood fish, propagation, research needs, and reintroduction of progeny to accomplish recovery goals. This hatchery's role in the recovery effort centers around the spawning and rearing of larval pallids. Pallid Sturgeon propagation at Garrison Dam NFH began in 1997. Successful spawning has occurred annually since1998. April 2002 marked the first stocking of yearling pallids from this facility. Past successful propagation of pallids have been cut short of stocking due to viral concerns and all progeny in past years were destroyed. Findings of iridovirus positive shovelnose sturgeon in the Yellowstone River, MT, near Miles City have led to the acceptance of stocking fish exposed to the virus.

Objectives

Objectives for this year will be twofold; one will be renewed emphasis on augmentation in RPA's 2, 3 and 4, the second will focus on identifying the source of the Shovelnose Sturgeon Iridovirus (SSIV) in RPA #1.

All four hatcheries used in past pallid propagation will be utilized in 2002. We will attempt to collect three females and nine males for spawning at Garrison Dam NFH. In addition to spawning and rearing of the nine 2002 'confluence' family lots, the hatchery will have a compliment of eggs from the Upper Missouri River spawning and will be holding 2001 'Upper Missouri River progeny' for stocking RPA #2 later this summer if given clearance from Montana's Fish Health Committee. Pairing for family lots will be based on results from the Genetics Lab at UC Davis. We plan on producing (3) 1X3 matings using the twelve broodfish. If eggs are abundant we may make 1X4 crosses to ensure survival of at least three family lots per female. We will also do trials on number of eggs fertilized/cryopreserved straw of milt. If enough pallid eggs exist we will be using them. Milt cryopreserved from 2000, male A65 will be used. The same male is available on station to cryopreserve additional straws for future use.

Miles City SFH will be supplied with four adults, three males and a single female. In addition to spawning in June they will be culturing four family lots from 2001 to a tagable size prior to stocking in RPA #2 later in the summer. Eggs from the Miles City spawning will be held at both the Miles City hatchery and Gavins Point NFH.

Bozeman FTC will also be culturing 2001 progeny further for stocking RPA #1. Plans are to spawn riverside again on the CM Russel Refuge. Eggs from this spawning event will be held at both the Bozeman hatchery and Garrison Dam NFH.

Work will continue on PCR confirmation tests and on locating SSIV positive adult sturgeon in the upper Missouri River above Fort Peck Reservoir. Research into the advancement of a PCR diagnostic test was to be accomplished at the University of California, Davis campus under the direction of Dr. Ron Hedrick. Additional samples of the 2001 year class fish that had been suspect for the virus were sent this Spring for use in the development and testing process.

Spring Stockings 2002

April 1 pit tagging began in the South 20 foot tank. A total of 1540 fish were tagged in two days (5.7 fish/minute with three crews). On April third the fish were loaded on Gavins Point's distribution truck and transported for stocking three locations on the Missouri River Nebraska/South Dakota boarder (St. Helena, Vermillion, Bellevue). The following week on April 9th fish from the North 20 foot tank (a mixture of the four confluence family lots plus culls too small to pit tag) were hauled to Blind Pony SFH in Missouri along with the remaining fish for stocking lower RPA #4 at Booneville, MO. Hauling temperature was 43°F and tagging temperature was 38°F. Tagging for the RPA #4 fish finished up on the 10th. It took two long days of pit tagging with three crews to tag 5,116 fish. On the 11th the fish were loaded on two trucks to make the trip south. Gavins Point truck hauled 221 pounds (3,564 fish) in four 200 gallon tanks and the Garrison truck hauled 108 pounds (1,552 fish) in a 175 gallon tank. The Gavins Point truck fish were offloaded onto a truck from Neosho NFH (3 compartment 250 gallon each) to complete their trip to Bellevue, Nebraska and Boonville, Mo. The fish stocked near Vermillion, SD completed the trip in 11 hours. They were hauled at 40°F . Oxygen was used - no Fresh-Flo's. Oxygen levels were difficult to control - Oxygen saturation was over 200%. The final Spring stocking went out on April 21st. RPA #3 received 70 fish each from 8 family lots (missing CIF X E09). A total of 560 fish were stocked along with 525 future brooders that were off loaded at Gavins Point NFH - representing all 9 family lots produced in 2001. The remaining 2001 fish at Garrison Dam NFH consisted of 345 each of the Upper Missouri River fish scheduled for stocking RPA #2. See Appendix 3. 2001 Pallid Stockings from Garrison Dam NFH

Spring Capture 2002

Methods and Results

Confluence Spawning
Through the efforts of the Montana Parks and Wildlife and US Fish and Wildlife personnel pallids were captured near the confluence for Spring spawning . Twenty-five fish were captured with all but five being recaptures. Three females and nine males were held at Garrison Dam NFH for spawning efforts. A single female and three males were transported to the Miles City SFH. The first week of collections folks from the USGS office in Columbia, Missouri were on hand to collect blood samples and do scoping/ultrasound of all the captured sturgeon. The second week sexing was based on catheterization, history, and guesswork See Table 1. Broodstock Data

Chronology of capture:

April 22 - Three boats fishing from 10:00 am through 7:00 pm. Nine fish collected, one gravid female and eight males. The fish (1F497F1801) was determined to be a female using ultrasound and confirmed with a sample of eggs taken by catheter. This fish had been collected in April 1995 and was determined to be gravid at that time. This fish along with three other males (1F482F3F2B, 7F7F065834, 115556461A) were transported to Miles City SFH. Five other males were collected, three sported transmitters (1F4A27214F, 1F4A111C6A, 7F7D3C5708). Two were recaptures (7F7D434B54, 1F4B225A1A). The 'male', A1A had previously been at the hatchery (2000) and collected in four of the past five years - a 'snaky' older looking fish. In 2000 it was injected but produced nothing, likely no longer capable of reproducing.

April 23 - Three boats fishing from 9:00 to 5:00. Six fish collected, one immature female, five males. There were three fish with transmitters, a male, tag #1F4A111C6A, had been collected the previous day, a second male #1F477B3A65 had expelled the transmitter, the third was tag # 1F4849755B. The male that expelled the transmitter had been at the hatchery and spawned on two other occasions in 1999 and 2000. Since no progeny had been stocked yet, it was taken to the hatchery. Third time is a charm. Two other males taken to the hatchery were #115544332A and one double tagged # 1F4A3E1445 / 1F4A2F3A2E. 'Male' # 32A was taken to Miles City last year and catheterized. No eggs were recovered and it was presumed to be an immature female. Ultrasound indicated it is a male. Both fish were recaptures. The fourth fish taken to the hatchery was misdiagnosed using ultrasound as a male. At the hatchery it was determined to be a female, # 115553544A, spawned at Garrison Dam NFH in 1999. Apparently the fish has immature eggs. It's weight is 10 pounds less that when captured 3 years earlier. No tears were noted in the Mullerian ducts from the catheterization in 1999. In defense of the ultrasound team, females with fully developed eggs were identified 100% and although the endoscope was unable to view through the thick wall of the Mullerian duct, it was able to confirm that there were no lasting holes in the duct due to previous catheterization procedures.

April 24 - Two fish collected, one a 'new' 37 pound female, # 4310187B69, the second a 53 pound male, #1F4772396F. The male had been collected in 1994, 1997, and 1999. In 1997 it was spawned at Garrison Dam NFH. No progeny have been released from this fish. Both fish were taken to Garrison Dam NFH for spawning.

April 25 - One 'new' 40 pound male pallid captured, tag # 115716093A. This fish had a rubber gasket from irrigation pipe stretched around it's head. The gasket had caused an ulcer and a indented ring around it's head and was a little on the lean side. The gasket was cut loose and the fish taken to the hatchery. Also collected was a mature female sturgeon of about 15 pounds. The fish was a suspect hybrid and was also taken to the hatchery (This fish grouped genetically with shovelnose sturgeon).

April 26 - One large male, a new fish, # 116167123A, was collected. The sturgeon had a rather large fish in it's gut that was confirmed with ultrasound. This fish was taken to the hatchery.

April 29 - Two fish were collected, one male, one female. The male # 7F7D434B54 was a recapture, the female # 116224546A, a 'new' fish. Both were taken to the hatchery.

April 30 - Three fish collected, two transmittered males (2202236E31, 115525534A) and a female # 1F5420727B. The female had been catheterized and biopsied in the Fall of 1997. No record of egg stage at that time-apparently an immature female but no confirmation. The Mullerian duct was also scoped- again, no tears were seen. Apparently the catheterization done in 1997 had completely healed. On May 1 the female was catheterized - mature eggs with a considerable amount of fat were removed.

May 1 - Two male recaptures were collected, one tag # 220F107A6F , the other double tagged #1F53312736 / 1F52167900. Both were taken to the hatchery. End of collections.

Seven of fifteen transmittered fish were collected, all males. A single transmittered female was located, #1F47715752, on several occasions. In spite of a considerable amount of effort, the fish was able to elude the trammel nets. It makes you wonder as to the effectiveness of the nets.

Also interesting to note: 5 of 25 fish collected were new fish, two females, three males.

June 3 - Eggs were taken from the three female candidates by catheter - Polarity index values indicated all three were ready with values ranging from 0.07 to 0.06. The catheter was also used to confirm the sex of male 1F53312736. Testes recovered from the fish had sperm cells that were activated by water.

June 4 - Female 115553544A, the fish spawned in 1999 was catheterized to confirm egg stage. As suspected this fish had immature white eggs. Interestingly, the fish also contained shriveled black eggs from an aborted 2001 spawning attempt. This fish apparently has a two year spawning cycle.

Table 1. Broodstock Data

PALLID STURGEON BROODSTOCK DATA 2002						
	Spawn Site	**Date**	**Sex**	**Wt lbs.**		**Capture Site**
1F497F1801	MC		F			
1F482F3F2B	MC	4/22/02	M		Milt cryopreserved	confluence
7F7F065834	MC	4/22/02	M		Milt cryopreserved	confluence
115556461A	MC	4/22/02	M		new fish, milt cryopreserved	confluence
1F4A27214F	RELES	4/22/02	M		Transmittered - Butch, 2001	confluence
1F4A111C6A	RELES	4/22/02	M		Transmittered - Ben, 2001	confluence
7F7D3C5708	RELES	4/22/02	M		Transmittered - Bob, 2001	confluence
7F7D434B54	RELES		M		Recapture	confluence
1F4B225A1A	RELES	4/22/02	M		Recapture	confluence
115544332A	GAD		M	55	deformed dorsal - died	confluence
1F4A3E1445	GAD	4/23/02	M	34	1F4A2F3A2E, two tags	confluence
1F477B3A65	GAD	4/23/02	M	28	Transmitter lost- Aaron,2000	confluence
115553544A	GAD	4/23/02	F	41	immature eggs - 6/4 catheter	
1F4849755B	RELES	4/23/02	M		Transmittered - Art, 2000	confluence
1F4772396F	GAD	4/24/02	M	53	spawned in 1997 - died	confluence
4310187B69	GAD		F	37		confluence
115716093A	GAD	4/25/02	M	40	new fish, gasket around head	confluence
116167123A	GAD		M	50	new fish	confluence
7F7D434B54	GAD	4/29/02	M	30	fins torn in net	confluence
116224546A	GAD	4/29/02		60	new fish - 6/3 catheter eggs	confluence
1F5420727B	GAD	4/30/02	F	68	5/1 catheter eggs - died	
2202236E31	RELES	4/30/02	M		Transmittered - Arnie, 2000	confluence
115525534A	RELES	4/30/02	M		Transmittered - Alex, 2000	confluence
1F53312736	GAD	5/01/02	M		1F52167900, catheter testes	confluence
220F107A6F	GAD		M	~50		confluence
411D0E2C5F	CMR	6/04/02	M		Recapture - milt refrigerated	Upper Mo. R

PALLID STURGEON BROODSTOCK DATA 2002						
Tag Number	**Spawn Site**	**Date**	**Sex**	**Wt lbs.**	**Other Info**	**Capture Site**
7F7D461025	CMR	6/11/02	M	30		Upper Mo. R.
132319571A	CMR		F	48	died - poor survival of prog.	Upper Mo. R.

Upper Missouri River Spawning

Water flows into Fort Peck were considerably higher this year than the past few with flows peaking at about 18,000 CFS on the 14th of June. Water turbidity was extremely high and water temperatures were lower than in the past. The Montana crews were out the first week of June netting for adult brood fish. On June 4th the first fish, a male #411D0E2C5F, was captured. River flows had increased to 10,000 CFS at this time. This fish was a recapture from last year. Milt was collected and stored refrigerated until spawning. Adult shovelnose were also collected and held in a net cage for spawning and iridovirus sampling. June 11th a pair of pallids were collected, one male #7F7D461025, and one female #132319571A. Garrison Dam NFH personnel were notified and plans were made to travel to the site. Warm Springs FTC personnel were also along to provide spawning assistance and for cryopreservation.

Before departure the following morning, attempts were made to collect milt from the sturgeon held at the hatchery. Males collected in the Upper Missouri River were producing milt at this time and we wanted to determine if fish held at the hatchery under similar temperatures would produce milt without injections. After an unsuccessful attempt to retrieve milt we departed for Montana. We arrived at the camp at 6:00 pm after a 8 hour trip. The female was catheterized and ~75 eggs were recovered for the progesterone assay and polarity index. The polarity index looked favorable with a range of 0.07-0.09. At 8:00 pm we injected four pair of shovelnose sturgeon using LH-RH. The males were given full dosages, the females one tenth of the total. The following morning the female shovelnose were given the resolving dose at 9:00 am. The rest of the day was spent netting for pallids (10:30 am to 4:00 pm), two boats - no captures. At 9:00 pm the pair of pallids were injected, the male with LH-RH (full dose) and the female with Ovaprim at the 1/10th rate. Water temperature in the tank was 65°F.

June 14th we began spawning shovelnose at 7:45am with ovulation occurring in one of the four fish. At 8:00 the female pallid was given the resolving dose of Ovaprim. 180 mls of milt was taken from the male pallid, the milt looked coagulated. Both pallids are fairly lethargic. Water temperature is 62°F. After collecting the milt, the water pump was started and water temperature in the tank dropped to 58°F. At 10:15 am the second female shovelnose ovulated. Eggs were recovered from both ovulated fish but in small quantities (~250 to 1000 eggs). At noon another small collection from the two shovelnose. At 2:15 one of the two unovulated females was dead. The fish was cut open and ovaries removed and placed in extender (HBSS) progesterone solution to evaluate the possibility of the eggs ovulating in solution - no luck. The eggs were also preserved and bisected to determine the presence/absence of the nucleus (Both ovulated and unovulated eggs underwent nuclear breakdown). Water temperature in the tank is at 64° F and the pump was shut off after running two hours. At 3:15 milt was again aspirated from the pallid. This take looks much better and is confirmed under scope. Bill and Jaci cryopreserved 100 - 0.5 ml straws for the repository. Bill noted that the milt was acidic, something he had not seen previously. At 4:00 pm a small amount of eggs are palpated from the shovelnose. The abdomen is very flaccid and a catheter is inserted - eggs are flowing. The fish is pithed and an incision is made to recover eggs. The female had completely ovulated. The second female is pithed and cut. She too was fully ovulated but by palpation we were able to collect only a small amount of eggs. This fish had many overripe eggs also free in the body cavity. The final shovelnose female is still unovulated. At 4:30pm, 7:30pm, midnight, 5:30am, 8:15am, 10:00am, 12:00 noon the female pallid is checked - no eggs. The fish should have ovulated around 8:00 am - a catheter was used to remove a sample of eggs at noon and milt was added. If the eggs recovered by catheter were ovulated, we should see cleavages in the eggs by 4:00 pm. At 2:00 pm still no eggs - the catheter tube was inserted and a few eggs expelled. At 4:00 we observed cleavage in a few of the eggs sampled earlier. We decided to remove the fish and recover eggs using the catheter. When the female was located (extremely silty water) in the tank she was dead - two hours after the last check. She was cut open to reveal the condition of the ovaries. The few eggs free in the body cavity were fertilized with milt from the two pallids. The ovaries were cut out, placed in a pan and milt was applied directly to the ovaries while 'combing' loose eggs from the mass. The eggs were incubated until 6:30, bagged and shipped to Bozeman. A small sample of the two crosses were bagged as a 'backup' and transported to Garrison Dam NFH. The male was released, the female wrapped and frozen at the Garrison hatchery. At the hatchery the eggs were incubated - survival was very low but we did have ~100 fry hatch on June 18th . By the 24th, the number of prolarvae alive was down to 30. No data was taken on total eggs collected. There was no survival on the pallid eggs incubated at the Bozeman Fish Technology Center and on the 18th the eggs were bagged and frozen.

Confluence Spawning at Garrison Dam NFH

June 17th catheter checks on the three females indicated that the polarity index of female 546A was acceptable for injection (the index was 0.1) and we had confirmation from the previous weeks progesterone assay that the fish was ready. The fish was injected the evening of the 17th and the resolving dose given the following morning. Ovaprim was used at the standard 0.5mg/kg rate. The fish was checked that evening at 11:30 (24 hours after initial injection) and again the following morning at 6:00. Periodic checks were made during the day. At 4:45 we catheterized the fish to check on the progression of ovulation. Eggs readily filled the catheter tube. Ovulation had apparently occurred but we were unable to express eggs by palpation. We collected eggs about hourly until midnight trying first to express them using palpation but then reverting to catheterization when palpation failed. We apparently timed the catheterization correctly, the first collection by catheter at 5:15 resulted in 93% fertilization - the best I've seen. We ended up collecting 1887 mls of eggs that evening and making 4 family lots. See Table 3. Spawning Results. In addition to the regular production lots, Bill Wayman of the Warm Springs Fish Technology Center used cryopreserved milt to fertilize two additional batches of eggs - one from cryopreserved milt from 2000 pit tag # 3A65 using (4) 0.5 ml straws, and the second from a 5 ml straw frozen last year with AKOS extender - pit tag # 1F4A27214F. Preliminary fertilization rates indicated 50.2% fertilization with the large 5 ml straw and only 6.2% with the smaller straws. See Table 2. Cryopreservation Data

Table 2. Cryopreservation Data

Cryopreservation Data (egg size 33.67/ml)								
Male tag #	Year	brood location	Straw size	% fert	mls of eggs	# of eggs used	fertile eggs	fry at 1 month
1F477B3A65	fresh	GAD	n/a	76.8	36	1212	931	N/A
1F477B3A65	2000	GAD	0.5 ml (4)	6.2	37	1246	77	14
1F4A27214F	2001	Miles City	5 ml (1)	50.2	147	4950	2485	953*

* 953 fish shipped to Gavins Point NFH 7/16/02 based on a total weight of 156 grams and a sample size of 99 fish/16.2 grams. - 636 eggs were preserved from the 4,950 used in the 5 ml straw trial to verify % fertilization data.

Table 3. Female # 116224546A - Spawning Results

FEMALE #116224546A						
TIME		**MALE #**	**MLS EGGS**	**@ 36.5/ML**	**Percent Fertilization**	**Estimated Hatch Number**
4:45 p	6/19/02	116167123A	11	402	~80	321
5:03 p	6/19/02	116167123A	26	949	~80	759
5:15 p	6/19/02	220F107A6F	410	14965	93.1	13932
5:20 p	6/19/02	116167123A	140	5110	81.5	4165
7:10 p	6/19/02	7F7D461025	142	5183	40.0	2073
7:15 p	6/19/02	7F7D461025	144	5256	54.5	2865
8:19 p	6/19/02	1F477B3A65	139	5074	~80	4059
8:27 p	6/19/02	116167123A	174	6351	~80	5081
9:18 p	6/19/02	1F477B3A65	306	11169	~80	8935
11:38 p	6/20/02	7F7D461025	175	6388	73.8	4714
12:18 a	6/20/02	1F477B3A65	36	1212	76.8	931
12:18 a	6/20/02	1F477B3A65	37	1246	6.2	77
12:18 a	6/20/02	1F4A27214F	147	4949	50.2	2485
7:30 a	6/20/02	116167123A	40	1460	0.0	0
8:00 a	6/20/02	1F477B3A65	191	6972	1.0	30
9:50 a	6/20/02	220F107A6F	114	4161	0.0	7
TOTAL			2232	80882		50434

Sample counts were made at the egg stage ‘elongation of pronephros.’ A total of 1569 eggs were measured in a 250 ml graduated cylinder. The line of egg level with water was 43 mls giving an egg size of 36.5 eggs/ml. Egg size of the cryopreserved eggs was accomplished in a 5 ml syringe. The egg size was determined to be 33.67/ml. Eggs were incubated in 68° F water. Fry were hatched directly into 30 inch circular tanks. As hatching progressed the jars were moved to additional tanks to keep the number of fry in any single tank at a reasonable number (~3,500). Feed was fed out using Sweeney vibrating feeders 24/7 at 15 minute intervals. BioOregon’s #1 starter diet was used. On June 20th eggs from the family 546A X 7A6F were shipped to the Miles City SFH via personal plane. A total of 200 mls were sent (an estimated 10,000 eggs). Survival on eggs was excellent.

Female # 1F5420727B was injected with Ovaprim at 11:30p on the evening of June 19th. The progesterone assay for this fish was positive on June 16 (previous week was negative) - nuclear breakdown had occurred in all eggs. The PI was good with an average of 0.09. The following morning the fish was given the resolving dose (11:20). The morning following the resolving dose the fish's behavior was very odd. Typically the injection will cause the fish's activity to increase. They swim aggressively around the perimeter of the tank moving with the water flow. The only movement of this fish during the day was noted when handling when there was limited resistance. It appeared to be in 'shock.' Handling of the fish occurred on three occasions during the day to check for ovulation. At 3:45 a catheter was used to recover a couple dozen eggs. Half were fertilized the others preserved to check for nuclear breakdown. After 7 hours it was apparent that the eggs were not viable. At 11:30 pm the fish was observed on it's side with very slow ventilations. It was apparent the fish was nearly dead. The fish was cathetered to recover eggs. Some eggs were removed but they were covered with fat. The eggs appeared in good condition - either recently ovulated or unovulated. After the initial collections a sample of eggs were taken that looked flaccid. It was thought that the fish had ovulated at that point and likely had good ovulated eggs still inside. Once the fish had died, an incision was made to remove the eggs. The condition of the ovaries was extremely fat. It appeared the eggs were unovulated but every attempt was made to fertilize the eggs. Eggs were combed from the ovaries, fat was removed and the eggs were incubated. Eggs were incubated four days without signs of development.

The final female, #4310187B69 was injected at 9:00 pm on June 24th. The fish was injected with Domperidone and LH-RH. The males were also injected at this time, half with LH-RH, the other three with Ovaprim. Immediately following injecting with Ovaprim the male #1F4772396F turned 'pink.' I have never seen a response like this in any other fish. The following morning at 8:00 am the female received the resolving dose. Milt was collected from 4 of the six injected fish. The two that didn't produce had been injected last week with the same results. The milt had good color however the motility was low on all but one. See Appendix 1. Milt collections. Ovulation checks began on the evening of the 25th at 11:00 pm. The fish was palpated again at 6:00 am with no eggs seen. At 8:30 am she was checked the third time - no eggs. Palpation at 11:45am resulted in 4 eggs collected. At 1:30pm the fish was palpated again, this time no eggs were observed. A catheter was inserted to determine state of ovulation. The tube was filled with a slate gray fluid and flaccid eggs. The fish had apparently ovulated much earlier and we were unable to determine ovulation using the preferred palpation method. The catheter was inserted again, this time farther anterior into the abdominal cavity to determine if any viable eggs were present. A total of 200 mls of eggs were collected and fertilized with a single male (7F7D434B54). The condition of the eggs was poor and the process abandoned to prevent stressing the female further.

During this time, eggs from the Miles City SFH spawning were sent to the hatchery. Two family lots were sent via private plane (1F497F1801 X 7F7F065834 - 396 mls and 1F497F1801 X 115556461A - 298 mls). The eggs arrived at 11:30 am and were treated with 100 ppm Betadine for 10 minutes upon arrival. Milt from one of the males (115544332A) held at Garrison Dam NFH was sent back to Miles City via plane to provide for production of a third family lot. On June 27 eggs from the third family produced (1F497F1801 X 115544332A - 100 mls) at Miles City were brought back via truck. No egg development was noted on the eggs received from Miles City and there was no survival at either hatchery from that female.

On June 28th the development of eggs taken from female pit tag #4310187B69 on the 25th was determined. As expected a sample relieved fertilization rates for this fish would be poor - 14.1% (from 283 eggs sampled, 40 were viable) . The egg stage at this time was characterized as 'elongation of the pronephros.' The total volume was 200 mls for an estimated 7,300 eggs. June

30th hatch began. A total of 1,300 fry hatched for an actual fertilization rate of 17.8%. Over the course of two weeks 95% of the hatched prolarvae died. As we have experienced in the past, poor quality eggs typically result in poor survival during the final stages of prolarvae development. We ended up with 63 surviving fingerlings at two months of age.

July 3rd two male adult pallids died, one in the morning, the other in the afternoon - nine days post injection. Both fish had negative reactions to the Ovaprim injections, the one turned pink immediately post injection, the other exhibited the typical porpoising response seen when under stress. The male 1F4772396F had was spawned here in 1997 and milt from this fish was cryopreserved this year. The other male, 115544332A had milt sent to Miles City but no progeny survived. Milt from this fish was also cryopreserved. Both fish were autopsied at the hatchery. Gonads were frozen as were livers and tissues from both fish and were sent to the Fish Technology Center. Internally and externally both fish looked good - the exception being some hemorrhaging in the gonads of male 332A (Male 332A was injected last year at Miles City but no milt was produced - males typically respond well to injections).

July 8th the fish health team was at Garrison Dam NFH collecting samples for virus testing. Five fish from each of four yearling family lots were lethally sampled. Fish from one family were under represented and were not sampled. In addition all but a single female pallid brood fish were sampled by fin clips.

On July 9th female 4310187B69 was found dead in the tank. The fish appeared to have recovered fine from the attempted spawn. The previous week she was expelling ovulated eggs in the tank and appeared to be fairly vigorous. While collecting fin samples the previous day from the other adult fish for virus testing she was much more lethargic. Because of this behavior she was not subjected to the stress of handling. The fish was autopsied to determine possible cause of death. An incision was made into the abdomen and a white fluid was present. The ovaries had fully ovulated and no ovulated eggs were present in the body cavity or ovaries. The ovaries contained white oocytes and appeared normal. The ovaries were removed as was the liver, frozen for shipment to Rick Barrows to assist in the development of sturgeon diets. The oviducts of this fish were dissected to determine if any inflammation or hemorrhaging had occurred during the catheterization process. Nothing was apparent, however it was noted and photographed that there appear to be pores in the inner lining of the Mullerian duct that may connect the duct with the kidney. The inner lining of the Mullerian duct is continuous with the outer lining of the kidney. I would assume that being the case, nitrogenous wastes which eliminated through the kidney pass into the Mullerian duct. With the Mullerian duct ruptured by the catheter those wastes could and likely do enter the body cavity. The overall effect may not be as critical as you might think since the bulk of the urinary nitrogen passes out of freshwater fish through the gills as ammonia and at this point are not clear as to the overall toxicity of the waste product (K.F.Lager et al, 1977). Tests will be conducted on surplus shovelnose to evaluate the catheterization process. We also have evidence from fish used as broodstock that have been catheterized as early as 1977 that survival is in fact likely, but this process may have contributed to the death of the fish. I would also hypothesize that if the wastes that are eliminated into the body cavity contain bacteria, it would likely result in an inflammatory response and that wasn't evident in the fish. Equally as plausible, a major contributing factor in the death would have been the overall stress the spawning process and the unknown effects of the hormone injections. Kidney failure or overload may also be occurring. The kidney's function is to eliminate metabolic wastes and purify the blood. Hormones action controls filtration and reabsorption in the kidney. Our hormone injection may create an imbalance of the kidney's function. In the case of ovulated females whose eggs are not expelled, the decomposing eggs no doubt create a huge load on the liver as well. I'm sure there are many other possible explanations - at this point nothing is conclusive.

July 16th we finally arranged to move fish to Gavins Point NFH to provide the 'backup' to the fish spawned here. The fish size was determined to be ~3000/lb and a total of 20,950 fish were packaged at1000/box and hauled to Yankton. The breakout of the shipment is as follows: 6,000 each for 2 family lots; 4,000 each for 2 family lots, and 950 of the final family. The 950 fish were estimated at 2774/pound and 156 grams were sent. Yankton received the entire compliment of this family since RPA #2 already has representatives stocked from both parents. This lot was a lot produced from last year's crypreserved milt. In addition 30 half ml straws of cryopreserved milt was sent for each male spawned this Spring to add to their repository. After shipping, the fish retained at Garrison were spread out equally among available tanks to reduce the loading density.

July 23rd, The MRFWMAO was up to haul pallid broodstock to the river. Five of the nine fish were shipped with the remaining scheduled for next week. Screens in the 2002 progeny were switched out to the aluminum slots. Received news back from Bozeman FHC that the smaller female (4310187B69) that had died on the 9th was found to be positive for the iridovirus. This represents the first adult pallid diagnosed as positive for the virus that I am aware of. To date no positive virus findings on the 2001 progeny but sampling is only half done.

Summer Stockings for RPA #2

Tagging operations for the RPA #2 stockings were done the afternoon of July 24th. Three crews of four were set up. Each fish was measured and injected with a pit tag into the base of the dorsal fin and green elastomer stripe into the rostrum. The process took about 5 hours for 1626 fish tagged (5.4 fish/minute). Water temperature at tagging was 67°F. No mortalities were noted. The following day the fish were loaded into the truck by stocking site, the heaviest tank had 62 pounds. Oxygen was used to maintain the DO level around 8 ppm. The fish were stocked at 5 locations as noted in Table 4.

Table 4. RPMA #2 Stockings - July 25th, 2002

Broodstock		Stocking Locations - RPMA #2					Total	
Female	Male	Sidney	Wolf Point	Fairview	Culbertson	Intake	Num	Lbs
		Num	Num	Num	Num	Num		
411D262C1F	1F4A4B5973	85	85	85	85	13	353	
411D262C1F	411D0E2C5F	86	85	85	64	0	320	
411D262C1F	41476A0462	85	85	85	85	84	424	

Broodstock		Stocking Locations - RPMA #2					Total	
411D262C1F	411DOB4E09	85	85	21	0	0	191	
411D262C1F	17509415139	86	85	84	83	0	338	
TOTALS		427	425	360	317	97	1626	2825

The day following stocking an angler reported catching an elastomer tagged sturgeon. He had caught another tagged fish five days earlier at Intake as well (Miles City fish had been released on the 17^{th}).

August 1 an inventory was performed on the 2002 year class and fish were moved from the 30 inch tanks to the 4 and 5 foot tanks. Another inventory was completed on August 23^{rd} . Growth rates were compared between the two sampling times relative to density and family lot. Density ranged from 0.08 to 0.44 pounds per square foot (40-235 fish/tank) using 1 month old fish. There was no significant difference between the tanks in growth or mortality. Fish on August 1 were receiving 132 grams/day of Biodiet #3 Starter in the large tanks, 66 grams (100 mls)/ day in the smaller tanks. Feeding was in excess and regulated to provide food every 15 minutes. The building was kept dark except during tours and cleaning.

Table 5. August Inventory on 2002 Progeny

Female	Male	Location	August 1			August 23
			Number	Weight	Size (gram/fish)	Size (grams/fish)
116224546A	1F477B3A65	Garrison Dam	6020	4491.4	0.75	3.53
116224546A	116167123A	Garrison Dam	5316	4767.8	0.90	3.97
116224546A	220F107A6F	Garrison Dam	2403	1852.3	0.77	4.17
116224546A	7F7D461025	Garrison Dam	1443	1143.2	0.79	-
4310187B69	7F7D434B54	Garrison Dam	64	31.2	0.49	-
132319571A	7F7D461025	Upper Missouri	15	18.4	1.23	-
1F497F1801	115556461A	Miles City SFH	1	0.8	0.80	-
				12305.		

Female	Male	Location	August 1			August 23
			Numbe r	Weigh t	Size (gram/fish)	Size (grams/fish)
Total			15262	1	0.81	11.67

August 12th, two-hundred ten pallids were sent to the Environmental Branch of the U.S. Army Corps of Engineers to determine how the juvenile sturgeon react to water flows. Terri Allen is conducting the research.

The fish were switched from a 1.0 mm Biodiet Grower to a Silver Cup #3 trout diet on August 18th. The transition was done in three days. The fish didn't appear to have much difficulty making the feed switch, however, the size may be a little large for the 'runts.' Mortality in August was from 0-2%. The bulk of the mortality was in two tanks that had some gill disease problems. An increase in water flow appeared to correct the problem.

Mid-August the Bismark FWMAO located a radio tagged female from the 2001 spawning near the Highway 85 bridge. After a few net drifts we were fortunate to capture the fish. The fish was catheterized to determine egg stage. No eggs were recovered and only ovarian tissue was removed. It is my opinion that this fish had spawned this Spring and if that is the case, it is likely that both the pallid and shovelnose are capable of spawning every other year.

September 15th increased feed to 200 grams (300 mls) and on the 24th to 265 grams (400 mls) per day - Silver Cup #4 trout crumble. Growth is good but we are losing some fish to starvation - worst case is ~8% loss and the higher dropout rate is present in only one of the four half sibling family lots. The other three family groups have monthly mortality rates closer to the 1% level. It has been about a month since switching feed brands. It is likely that the emaciated fish are those that did not convert to the new diet. On the first of October fish were removed from the tanks to lower densities to 310 fish per 5 foot tank and 210 fish per 4 foot tank. That density equates to 19.7 and 16.7 fish/sqft respectively and should provide a density of 1 pound per square foot or less at stocking time. On October 4th and again on the 7th the excess fish were sampled to determine growth rates and disposed of. Progeny from the 546A X 3A65 family had a mean length of 164 mm and a mean weight of 16.1 grams. Progeny from the 546A X 123A family had a mean length of 175 mm and a mean weight of 18.7 grams. The minimum size was 88 mm and maximum was 212 mm. The mean condition factor (K) for 200 fish sampled was 3,348 X 10^{-6}.

October 24th the Bozeman FHC crew was on site to take samples. A total of 60 lethal samples were taken, 15 from each of the four half sibling family lots. Received the final report on the 2001 progeny - no viral infections found. It was noted that 'low to moderate levels of inflammation were observed in all lethal samples' and epithelial tissue indicated melanization, degeneration, and necrosis. On a positive note, the fish had fatty livers rated from mild to moderate with no associated pathology and internal organs appeared healthy in contrast to last years findings when many were rated severe. The diet used through this July's sampling were the same as last year's.

November 7th a sample of 16 pallids was taken to evaluate size and growth. The mean length at this time was 194 mm and weight 26.4 grams. The size range was from 160 mm to 255 mm FL. The K value was 3,300 X $10^{-6.}$ The 2001 progeny sampled on November 29, 2001 averaged 24 grams each and were 194 mm FL. Last year's early April stocking had an average length of 200 mm and average weight of 30 grams. We are nearly there.

Side Notes

The shovelnose catheterization tests indicate that there is no apparent short term affect from the procedure in immature shovelnose. In several fish, the Mullerian duct was purposely ruptured into the kidney and still no mortality. Since we have documented survival in adult pallids that have undergone several catheterizations, I'm not convinced that the procedure poses a greater risk than an incision to determine egg stage and sex. In fact, I would still recommend catheterization as what I consider the less evasive of the two procedures.

The Ovaprim bottle used on the pallid sturgeon this Spring was injected into 50 shovelnose sturgeon to determine if there was a possible contamination problem or toxicity. To date none of the injected fish have shown any adverse effects. The shovelnose were all immature fish (11/2 years old).

On the two suspect hybrid sturgeon:
Pit tag #115676690A - genetics results lean toward calling this fish a pallid. The fish was captured in the confluence on 4/18/2000. At that time the catheterization check showed small yellow eggs. The fish was catheterized later that summer on September 27 and the eggs were 2.5 mm and black. The fish was overwintered in a hatchery pond. She should have spawned in the Spring of 2001. This May she was catheterized and had small yellow eggs with small 'raisined'

black eggs. She will be ready to spawn in the Spring of 2003. The second suspect hybrid was captured on 4/25/02. This hybrid grouped with the rest of the shovelnose genetically. She had fully developed black eggs at the time of capture. The catheterization check on 10/01/02 revealed resorbing black eggs.

I had sent off pallids from 2001 that were OTC marked at seven weeks old to determine if the marks could be seen. Ron Brooks read the marks on both otolith and spine. He indicated the fish could be marked as week old fry. We are currently marking day old walleye fry with 98% success.

August 1 trawling by Pat Braaten and Dave Fuller indicated that there was a wide range of spawning events. They had collected sturgeon from 15-81 mm in length (a 15 mm fish is likely only a couple weeks post hatch). The three smallest fish (15,18 & 22 mm) were collected near the Hwy 85 bridge. In September were trawling between the Hwy 85 bridge and the Nohly bridge and collected sturgeon 17-25 mm in length. The fork length of fish at the hatchery during that time was 16-20 cm, ten times larger.

Prolarvae pallid behavior in 68° F water indicated the switch from random dispersal in the tank to benthic orientation with directional alignment between day 10 and 11. That behavior change also signals initiation of feeding although feed is introduced prior to that stage to stimulate the feeding response. The eggs hatch in four days at that temperature. From a hatchery perspective it is advantageous to increase the screen size immediately prior to the fish's behavior change and increase screen size as frequently as possible to facilitate excess feed and fecal removal and avoid contracting bacterial gill disease.

Corps of Engineers funding was used to purchase float valves necessary to control heated water spillage, a fifth wheel trailer for the adult pallid distribution unit, a replacement UV bulb, cryopreservation supplies and a backup milt storage dewar to be maintained at Warm Springs FTC, new screening materials for tanks, and a digital camera capable of photographing egg stage for determining polarity indices.

Appendix 1. Milt Collections

Milt Collections								
Pit Tag #	mls	Hormone	Inj Date	Inject Time	Take Date	Time	Motility	Characteristics
115544332A	265	Ovaprim	6/20	11:30 p	6/21	9:25 a	90	milky
115544332A	195	Ovaprim	6/24	9:00 p	6/25	1:00 p	15	skim
1F4A3E1445	300	Ovaprim	6/24	9:00 p	6/25	1:00 p	80	skim
1F477B3A65	210	Ovaprim	6/17	9:30 p	6/18	1:55 p	90	skim
1F477B3A65	350	Ovaprim	6/17	9:30 p	6/19	9:15a	90	1% milk
1F4772396F	180	Ovaprim	6/24	9:00 p	6/25	1:00 p	35	skim
115716093A	2	Ovaprim	6/20	11:30 p	6/21	9:25 a	na	clear
115716093A	1	Ovaprim	6/20	11:30 p	6/21	8:00 p	na	clear
115716093A	35	LH-RH	6/24	9:00 p	6/25	1:00 p	na	clear
116167123A	180	Ovaprim	6/17	9:30 p	6/18	1:55 p	90	clear
116167123A	260	Ovaprim	6/17	9:30 p	6/19	9:15a	75	skim
7F7D434B54	235	Ovaprim	6/20	11:30 p	6/21	9:25 a	1	skim
7F7D434B54	180	Ovaprim	6/20	11:30 p	6/21	8:00 p	40	1% milk
7F7D434B54	200	LH-RH	6/24	9:00 p	6/25	1:00 p	40	milky
1F53312736	25	Ovaprim	6/17	9:30 p	6/18	1:55 p	na	clear
1F53312736	40	Ovaprim	6/17	9:30 p	6/19	9:15a	na	clear
1F53312736	5	LH-RH	6/24	9:00 p	6/25	1:00 p	na	clear
220F107A6F	120	Ovaprim	6/17	9:30 p	6/18	1:55 p	90	clear
220F107A6F	350	Ovaprim	6/17	9:30 p	6/19	9:15a	85	skim
7F7D461025	?	LH-RH	6/13	9:00 p	6/19	7:00p		

Appendix 2. Milt repository

Pit Tag	Year	RPMA	Straw Size (ml) ~ #		# Goblets	Dewar #	Comments
214F	2001	2	0.5	15	3	1	
1C6A	2001	2	0.5	10	2	1	
222A	2001	2	0.5	10	2	1	
5708	2001	2	0.5	10	2	1	
5708	2001	2	5	4	0	2	
1C6A	2001	2	5	4	0	2	
214F	2001	2	5	3	0	2	
222A	2001	2	5	3	0	2	
4E09(2265)	2001	1	0.5	5	1	3	MeOH
4E09(2265)	2001	1	5	3	0	3	MeOH
214F	2001	2	0.5	3	1	3	MeOH
214F	2001	2	5	1	0	3	MeOH
4773	2000	2	0.5	5	1	4	
6E31	2000	2	0.5	5	1	4	
453A	2000	2	0.5	5	1	4	
4552	2000	2	0.5	5	1	4	
194B	2000	2	0.5	5	1	4	
3350	2000	2	0.5	5	1	4	
5139	2000	1	0.5	10	2	4	
0462	2000	1	0.5	10	2	4	
2C5F	2000	1	0.5	10	2	4	
4E09 (2265)	2000	1	0.5	10	2	4	
5973	2000	1	0.5	5	1	4	
4B54	2002	2	0.5	20	4	5	
3A65	2002	2	0.5	5	1	5	
1025	2002	1	0.5	20	4	6	
5834	2002	2	0.5	20	4	6	
461A	2002	2	0.5	20	4	7	
3A65	2002	2	0.5	35	7	7	

Pit Tag	Year	RPMA	Straw Size (ml) ~ #		# Goblets	Dewar #	Comments
396F	2002	2	0.5	20	4	8	
7A6F	2002	2	0.5	20	4	8	
123A	2002	2	0.5	20	4	9	
1445	2002	2	0.5	20	4	9	
332A	2002	2	0.5	20	4	10	

Appendix 3. 2001 Pallid Stockings from Garrison Dam NFH

Broodstock		Stocking Locations							Total
Female	Male	Vermillion, SD	Bellevue, NE	Booneville, MO	RPMA # 2	RPMA # 3	Blind Pony SFH (runts)	Gavins Point NFH	Fish Stocked
411D262C1F	1F4A4B5973	28	20	20	353	70	56	50	589
411D262C1F	411D0E2C5F	557	554	558	320	70	56	50	2165
411D262C1F	41476A0462	600	580	564	424	70	47	50	2335
411D262C1F	411DOB4E09	0	0	0	191	0	0	28 77r	427
411D262C1F	17509415139	67	51	51	338	70	14	50	641
Half Sibling Family Total		1252	1205	1193	1626	283	173	228	5960
220E345E09	1F4A111C6A	339	339	362	0	70	0	50	1160
220E345E09	1F4A27214F	256	250	256	0	70	0	50	882
Half Sibling Family Total		595	589	618	0	140	0	100	2042
7F7F06672B	7F7D3C5708	172	199	198	0	70	60	50	749
7F7F06672B	115631222A	133	118	180	0	70	68	50	619
Half Sibling Family Total		305	317	378	0	140	128	100	1368
Confluence Mix	Tank N20	0	0	0	0	0	1721/174r	0	1721
TOTALS		2152	2111	2189	1602	560	2196	428	11288

Appendix 4. November Inventory

Tank #	_	_	August 1 Inventory	Aug mort	Sept mort	Oct mort	Number disposed	November 1 Inventory	Total % mort
T 51	546A	3A65	350	3	4	0	33	310	2%
T 58	546A	3A65	350	23	12	0	270	45	-
T 59	546A	3A65	350	12	3	0	25	310	5%
T 67	546A	3A65	250	9	17	-	224	0	-
T 69	546A	3A65	250	2	0	0	38	210	1%
T 72	546A	3A65	350	1	3	0	36	310	1%
T 73	546A	3A65	350	2	17	0	21	310	6%
T 74	546A	3A65	350	4	3	1	33	309	3%
T 75	546A	3A65	350	4	10	0	26	310	4%
T 81	546A	3A65	250	2	22	-	226	0	-
LOT TOTAL			3200	62	91	1	932	2114	7%
T 52	546A	123A	350	3	1	0	36	310	1%
T 53	546A	123A	350	3	1	0	36	310	1%
T 54	546A	123A	350	4	0	0	36	310	1%
T 70	546A	123A	250	2	0	0	38	210	1%
T 76	546A	123A	350	3	0	0	37	310	1%

Tank #	_	_	August 1 Inventory	Aug mort	Sept mort	Oct mort	Number disposed	November 1 Inventory	Total % mort
T 77	546A	123A	350	1	1	0	38	310	1%
T 78	546A	123A	350	1	1	0	38	310	1%
T 79	546A	123A	247	8	0	0	194	45	-
T 80	546A	123A	250	0	1	-	249	0	-
T 83	546A	123A	250	0	0	-	250	0	-
LOT TOTAL			3097	25	5	0	952	2115	1%
T 56	546A	7A6F	350	1	3	0	36	310	1%
T 57	546A	7A6F	350	3	2	0	35	310	2%
T 60	546A	7A6F	350	0	1	0	39	310	0%
T 61	546A	7A6F	350	0	4	0	36	310	1%
T 62	546A	7A6F	350	1	3	0	36	310	1%
T 63	546A	7A6F	350	4	0	0	36	310	1%
T 68	546A	7A6F	251	6	13	0	22	210	8%
T 80	546A	7A6F				0	45	45	0%
LOT TOTAL			2351	15	26	0	240	2070	2%
T 50	546A	1025	350	2	1	0	15	332	1%
T 55	546A	1025	193	2	0	0	0	191	1%

Tank #	_	_	August 1 Inventory	Aug mort	Sept mort	Oct mort	Number disposed	November 1 Inventory	Total % mort
T 64	546A	1025	300	6	1	0	0	293	2%
T 65	546A	1025	300	9	0	0	0	291	3%
T 66	546A	1025	300	0	5	0	0	295	2%
LOT TOTAL			1443	19	7	0	15	1402	2%
T 71	7B69	4B54	63	0	0	0	0	63	0%
LOT TOTAL			63	0	0	0	0	63	0%
T 82	571A	1025	15	0	0	0	0	15	0%
LOT TOTAL			15	0	0	0	0	15	0%

Appendix 5. Pallid Augmentation in Recovery Priority Areas 1-3.

Pallid Augmentation in the Upper Basin

Year	Hatchery of origin Mating design Effective population(Ne)	Female Pit tag (last 3 digits)	Male Pit tag (last 3 digits)	RPA #1			RPA #2			RPA #3			Total stocked per family
				Number stocked	Cumulative Effective population size (Ne)	Cumulative Frequency of inbreeding (F/gen)	Number stocked	Cumulative Effective population size (Ne)	Cumulative Frequency of inbreeding (F/gen)	Number stocked	Cumulative Effective population size (Ne)	Cumulative Frequency of inbreeding (F/gen)	
1997	Gavins Point NFH 2 x 3* Ne = 4.8	E04	439	138	4.8 2 X 3	10.4 %	151	4.8 2 X 3	10.4 %	80	4.8 2 X 3	10.4 %	369
		E04	A07	138			155			80			373
		E04	83D	138			155			79			372
		354	439	138			163			76			377
		354	A07	138			155			101			394
1998	Garrison Dam NFH 1 X 2 Ne = 2.7	171	123	0	4.8 2 X 3	10.4 %	100	7.5 3 X 5	6.7 %	49	7.5 3 X 5	6.7 %	149
		171	031	0			100			49			149
1999	Gavins Point NFH 1 X 2* Ne = 2.7	573	774	0	4.8 2 X 3	10.4 %	159	10.2 4 X 7	4.9 %	67	10.2 4 X 7	4.9%	159
		573	83D	0			159			50			159
		573	62A	0			160			65			160
2001	Miles City SFH	E09	C6A	0	4.8 2 X 3	10.4 %	366	12.9 5 X 9	3.9%	0	10.2 4 X 7	4.9%	366
		E09	14F	0			366			0			366

Pallid Augmentation in the Upper Basin

Year	**Hatchery of origin** Mating design Effective population(Ne)	**Female** Pit tag (last 3 digits)	**Male** Pit tag (last 3 digits)	**RPA #1**			**RPA #2**			**RPA #3**			**Total stocked per family**
				Number stocked	Cumulative Effective population size (Ne)	Cumulative Frequency of inbreeding (F/gen)	Number stocked	Cumulative Effective population size (Ne)	Cumulative Frequency of inbreeding (F/gen)	Number stocked	Cumulative Effective population size (Ne)	Cumulative Frequency of inbreeding (F/gen)	
	(2) 1 X 2 Ne = 5.4	72B	708	0	4.8 2 X 3	10.4 %	247	15.5 6 X 11	3.2%	0	10.2 4 X 7	4.9%	247
		72B	22A	0			298			0			298
2001	Bozeman FTC 1 X 5 Ne = 3.3	CIF	973	494	8.7 3 X 8	5.7 %	0	15.5 6 X 11	3.2 %	0	10.2 4 X 7	4.9%	494
		CIF	C5F	289			0			0			289
		CIF	462	553			0			0			553
		CIF	E09	176			0			0			176
		CIF	139	546			0			0			546
2001	Garrison Dam NFH	E09	C6A	0	8.7 3 X 8	5.7 %	0	15.5 6 X 11	3.2 %	70	12.9 5 X 9	3.9 %	70
		E09	14F	0			0			70			70
	(2) 1 X 2 Ne = 5.4	72B	708	0	8.7 3 X 8	5.7 %	0	15.5 6 X 11	3.2 %	70	15.5 6 X 11	3.2 %	70
		72B	22A	0			0			70			70
	1 X 5 Ne = 3.3	CIF	973	0	8.7 3 X 8	5.7 %	353	19.5 7 X 16	2.6 %	70	19.1 7 X 15	2.6 %	423
		CIF	C5F	0			320			70			390
		CIF	462	0			424			70			494

Pallid Augmentation in the Upper Basin

Year	**Hatchery of origin** Mating design Effective population(Ne)	**Female** Pit tag (last 3 digits)	**Male** Pit tag (last 3 digits)	**RPA #1** Number stocked	**RPA #1** Cumulative Effective population size (Ne)	**RPA #1** Cumulative Frequency of inbreeding (F/gen)	**RPA #2** Number stocked	**RPA #2** Cumulative Effective population size (Ne)	**RPA #2** Cumulative Frequency of inbreeding (F/gen)	**RPA #3** Number stocked	**RPA #3** Cumulative Effective population size (Ne)	**RPA #3** Cumulative Frequency of inbreeding (F/gen)	**Total stocked per family**
		CIF	E09	0			191			0			191
		CIF	139	0			338			70			408
2002	Garrison Dam NFH	546A	3A65	0	8.7	5.7 %	?	22.9	2.2 %	0	19.1	2.6 %	
		546A	123A	0	3 X 8		?	8 X 20		0	7 X 15		
	1 X 4 Ne = 3.2	546A	7A6F	0			?			0			
		546A	1025	0			?			0			
	1 X 1 Ne = 2.0	7B69	4B54	0			0			0			
	Gavins Point NFH	546A	3A65	0	8.7	5.7 %	0	22.9	2.2 %	?	22.5	2.2 %	
		546A	123A	0	3 X 8		0	8 X 20		?	8 X 19		
	1 X 5* Ne = 3.3	546A	7A6F	0			0			?			
		546A	1025	0			0			?			
		546A	214F	0			0			0			
2002	Miles City SFH	546A	7A6F	0			?			0			

Pallid Augmentation in the Upper Basin													
Year	**Hatchery of origin** Mating design Effective population(Ne)	**Female** Pit tag (last 3 digits)	**Male** Pit tag (last 3 digits)	**RPA #1**			**RPA #2**			**RPA #3**			**Total stocked per family**
				Number stocked	Cumulative		Number stocked	Cumulative		Number stocked	Cumulative		
					Effective population size (Ne)	Frequency of inbreeding (F/gen)		Effective population size (Ne)	Frequency of inbreeding (F/gen)		Effective population size (Ne)	Frequency of inbreeding (F/gen)	
Total				2748	8.7	5.7 %	4360	22.9	2.2 %	1289	22.5	2.62%	906

FISCAL YEAR 2002 STURGEON ACTIVITIES AND ACCOMPLISHMENTS

by

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November 18, 2002

The Gavins Point National Fish Hatchery (NFH) has been involved in the propagation and recovery of the endangered pallid sturgeon for at least 12 years. Additionally, the hatchery is one of the primary cultural facilities for the recovery of depleted, endangered, "Species of Concern", and candidate fish with primary emphasis focusing on the paddlefish, shovelnose and pallid sturgeon, and lesser emphasis on the sturgeon and sicklefin chubs and the surrogate flathead chub. The Gavins Point NFH was designated as the lead facility for the propagation and stocking of these species. Our field station is currently holding 26 families (6 year-classes) of future pallid sturgeon broodstock; rearing two year-classes of juveniles for stocking purposes; sampling these fish for disease; conducting INAD (LHRH) investigations; and completed more modifications to accommodate the Sturgeon and Endangered Species Buildings to culture unique species of fish. Our hatchery is no longer holding, maintaining, spawning, or stocking shovelnose sturgeon.

Fiscal Year 2002 was the fifth consecutive year that pallids were stocked in the Missouri River Basin from our hatchery, with these fish being stocked above and below Lewis and Clark Lake. Pallid Sturgeon Recovery Plan (PSRP) objectives were addressed through agency cooperation, research, and hatchery propagation. Our hatchery continues to operate at capacity in an effort to produce fish that will be stocked in high Recovery Priority Management Areas (RPMA) throughout the upper Missouri River and its tributaries. No spawning of any sturgeon occurred at our hatchery during Fiscal Year 2002; but spawning did occur at the Miles City SFH, MT, with the Gavins Point NFH taking the lead on this work. Disease inspections (for iridovirus) have been conducted at the Gavins Point NFH for the last several years with the pallid sturgeon testing positive, but not symptomatic. Sturgeon propagation and stocking has been drastically affected by viral concerns.

The short-term goal of the PSRP is to prevent extinction of the pallid sturgeon species. This may only be possible by removing adults from the wild, propagating and stocking fish, and establishing captive broodstock populations. The long-term recovery objective of this plan is to recover and restore these fish in the freeflowing reaches of the Missouri River Basin. Additionally, the objective is to downlist and delist the species by 2040 through protection and habitat restoration activities, provided that the following criteria are met: 1) naturally reproducing, self-sustaining populations exist within each recovery area, and that 2) a minimum of 10 per cent of the sturgeon population within each recovery area is comprised of mature females.

The following is an account of what has been accomplished at the Gavins Point NFH during the 2002 Fiscal Year - chronologically:

February 25 - Approx. 5,219 pallid sturgeon weighing 358 lbs. from the Miles City SFH, MT, were transported to the Gavins Point NFH were they were transferred to the Neosho NFH, MO, distribution truck for delivery to the federal hatchery in Missouri. They were reared, tagged, and stocked in the lower Missouri River downriver from the Gavins Point Dam. These fish resulted from the spawning that was cooperatively completed by the staffs from the Valley City NFH, ND; Miles City SFH, MT; and the Gavins Point NFH, SD, in June, 2001.

March 8 - We received the Sturgeon/Paddlefish Fish Health Assessment Report from the Bozeman Fish Health Center, MT, which shows the results of the iridovirus sampling completed on January 30. According to this report only 1 fish (analyzed histologically) from the 1998 year-class was positive for iridovirus, but only had a "mild infection" (no clinical signs). Other year-classes showed no signs of iridovirus when histological examination was used. PCR analysis on all of these sturgeon year-classes had not been completed up to this point in time.

March 19 - Our hatchery was involved with the Pallid Sturgeon Hatchery Meeting at the Corps of Engineers Office located near the Gavins Point Dam. This was a planning meeting involving pallid sturgeon activities, such as spawning, rearing, cultural activities, research, stocking, tagging, and funding, etc. This meeting involved funding from the Corps of Engineers for propagation activities in hatcheries.

March 29 - We received the Amendment to the Pallid Sturgeon Propagation and Augmentation Plan For Recovery Priority Management Areas 4 and 5 reflecting the changes that will allow stocking of pallid sturgeon in these areas downriver of Gavins Point dam. These fish were to be stocked from Garrison Dam NFH, ND; Gavins Point Dam NFH, SD; and Neosho NFH, MO. All fish were PIT-tagged, and all year-classes and family groups were divided into three approximately equal groups and stocked in Missouri River segments 10, 12, and 14 as identified in the FWS Biological Opinion.

April 3 - Mark Drobish returned from the Garrison Dam NFH, ND, with a load of tagged pallid sturgeon for stocking in the Missouri River below Gavins Point Dam. After stopping at the Gavins Point hatchery to refuel Mark and Herb Bollig stocked a total of 1,070 pallids in the following areas: 1) 23 lbs.@ 12/lb.=280 fish at St. Helena, NE; 2) 21 lbs.@ 15/lb.=320 fish at Mulberry Bend, NE; and 34 lb.@ 14/lb.=470 fish at Bellevue, NE.

April 9 - Jim Louma brought a total of 2,666 tagged pallid sturgeon from the Garrison Dam NFH to be stocked at the Blind Pony SFH, MO (2,196 fish), and Booneville, MO (570 fish).

April 11 - Rob Holm and Mark Drobish brought tagged pallid sturgeon from Garrison Dam NFH to be loaded onto the Neosho NFH truck to be stocked in the Missouri River near Bellevue, NE (1,751 fish), and Booneville, MO (1,813 fish). Rob stocked 1,552 pallid sturgeon at Mulberry Bend (Missouri River) before returning to North Dakota.

April 15 - A total of 116 pallid sturgeon from the 1999 year-class were PIT tagged for the ceremonial stocking event at the Ponca State Park, NE, that was held on 4/23/02 during the Missouri River Natural Resources Conference. A total of 35 pallid sturgeon from the 1997 year-class and 64 pallids from the 1999 year-class were PIT tagged prior to this day for the same stocking purpose.

April 21 - A total of 32.8 lbs.@ 16.01 fish/lb.= 525 juvenile pallid sturgeon from the 2001 year-class were shipped to the Gavins Point NFH from the Garrison Dam NFH, ND. All of the fish were elastomere-tagged using various colors and color combinations to identify the nine family groups.

April 25 - An additional 534 pallid sturgeon juveniles were PIT-tagged during the day. After tagging was completed 182 fish weighing 118.2 lbs. were stocked below Fort Randall Dam near Greenwood, SD (also called Sunshine Bottoms).

May 2 - A total of nearly 128 lbs.@ 1.465 fish/lb.=187 pallid sturgeon were stocked in the Missouri River near Bellevue, NE; and 112 lbs.@ 1.476 fish/lb.=165 pallid sturgeon were stocked in the Missouri River near Booneville, MO.

May 23-24 - All of the 1999 year-class pallid sturgeon broodstock were PIT-tagged. A total of 57.6 lbs.@ 1.28 fish/lb.=74 fish were tagged and will be used for spawning purposes in the future.

June 24-25 - Herb Bollig traveled to the Miles City SFH, MT, to stage the eggs from the one pallid sturgeon female that was being held there for that purpose. Three males were, also, being held for crossing with the female. The female was cathetorized, and the eggs were staged. The eggs APPEARED to be ready for ovulation. The female and the males were injected with the appropriate amounts of LHRH hormone. All sperm (milt) was precollected throughout the spawning effort. The female began ovulating and shedding eggs at 8:00 p.m. MDT on 6/24/02, and she was spawned four times (~once per hour) up until midnight and crossed with two of the three males' milt. One of the males did not spermiate - perhaps this male was not a male at all??? The female was spawned again on 6/25/02 from 6:00 a.m. until 12:00 noon (~once every two hours) with crosses being made with the two good males. It was decided to move the eggs crossed with the two good males and some of the raw milt to the Garrison Dam NFH, ND. This was done, and some of the milt from one of the males spermiated at Garrison was brought back to Miles City to make a cross with the female that we were spawning. Therefore, we made three family crosses during this particular spawning operation producing approximately 150,000 green eggs. Along with the one family that was made and brought to Miles City from Garrison last week, the Miles City hatchery has a total of four families to be incubated, hatched, and reared for later stocking and future broodstock establishment and maintenance. Eventual eyeup and hatch was very poor from the female that was being held at the Miles City hatchery. Cause of this disappointing egg performance is unknown. The female was not one of the better ones that was ever spawned during the life of this program??? Maybe we will do better next time. Previous cathetorizations and egg staging has shown the female's eggs were progressing towards maturation, but not nearly as quickly as had other females that we had spawned in the past. The oocytes did not look quite as good either. Maybe there was something wrong with this female and her entire egg maturation and spawning timetable!

July 15 - The hatchery received the Pallid Sturgeon Propagation Plan that was developed by Mark Drobish, COE, Yankton, SD.

July 16 - Matt Bernard transported approximately 20,950 pallid sturgeon feeding fry from the Garrison Dam NFH to our hatchery for further rearing, transfer to other hatcheries, and stocking. A total of five family groups contributed to these fish with one being made from a cross between eggs from a female and cryopreserved milt from a male whose sperm had been frozen in liquid nitrogen for about one year.

September 4 - A total of 2,000 pallid sturgeon juveniles from the 2002 year-class weighing 23.1 lbs. were shipped to the Columbia Lab, MO, to be used in their approved research pertaining to the recovery of that species.

September 24 - A conference call was conducted between all of those who are involved with pallid sturgeon propagation and culture. The topic of discussion was the number of 2002 pallid sturgeon year-class fish that will be held at each of the culture facilities. A recommendation was made as to how many of these fish will be disposed of; and the number to be stocked within each of the Recovery Priority Management Areas (RPMA).

Addendum

The hatchery staff has made several off-site presentations concerning endangered species and other parts of the hatchery program to school children, philanthropic organizations, civic groups, and campground visitors. During hatchery tours visitors received a summary of the past and present accomplishments of the paddlefish and sturgeon production programs.

Fort Peck Flow Modification Biological Data Collection Plan

Summary of 2002 Activities

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Abstract

The Missouri River Biological Opinion developed by the U. S. Fish and Wildlife Service formally identified that seasonally atypical discharge and water temperature regimes resulting from operations of Fort Peck Dam have precluded successful spawning and recruitment of pallid sturgeon *Scaphirhynchus albus* in the Missouri River below Fort Peck Dam. In response, the U. S. Army Corps of Engineers (USACE) proposes to modify operations of Fort Peck Dam to enhance environmental conditions for spawning and recruitment of pallid sturgeon. The Fort Peck Flow Modification Biological Data Collection Plan (hereafter Fort Peck Data Collection Plan) was implemented in 2001 to evaluate the influence of proposed flow and temperature modifications on physical habitat and biological response of pallid sturgeon and other native fishes. Activities continued during 2002, and are summarized below. The multi-year Fort Peck Data Collection Plan is comprised of five monitoring components: 1) measuring water temperature and turbidity at several locations downstream from Fort Peck Dam, 2) examining movements by pallid sturgeon that inhabit areas immediately downstream from Fort Peck Dam, 3) examining flow- and temperature-related movements of paddlefish *Polyodon spathula*, blue suckers *Cycleptus elongatus*, and shovelnose sturgeon *Scaphirhynchus platorynchus*, 4) quantifying larval fish distribution and abundance, and 5) examining food habits of piscivorous fishes. The Fort Peck Data Collection Plan is supported by the USACE, and implemented by the Montana Department of Fish, Wildlife, and Parks (MTFWP) and the U. S. Geological Survey Columbia Environmental Research Center.

Proposed flow modifications were not implemented in 2002 due to inadequate precipitation and insufficient reservoir levels. Continuous-recording water temperature loggers positioned at 17 locations provided baseline water temperature profiles to which changes in water temperatures resulting from modified dam operations could be compared. In the absence of modified dam operations in 2002, mean water temperature between mid-May and mid-October was 6.0°C cooler immediately downstream from Fort Peck Dam (mean = 11.9°C) than in the free-flowing Missouri River upstream from Fort Peck Dam (mean = 17.9°C). Water temperature 288 km (179 miles) downstream from Fort Peck Dam averaged 1.2°C less than above Fort Peck Dam. Similar to 2001, adult pallid sturgeon were not found in selected areas immediately downstream from Fort Peck Dam. Consequently, pallid sturgeon were not implanted with radio transmitters. Between April and November 2002, telemetry relocations were obtained for 16 blue suckers (160 relocations), 27 shovelnose sturgeon (276 relocations), and 18 paddlefish (134 relocations) in the Missouri River and Yellowstone River. Six continuous-recording telemetry logging stations positioned in the Milk River and five additional stations positioned at sites between Fort Peck Dam and Culbertson logged an additional 376 contacts of radio-implanted fish. Shovelnose sturgeon and paddlefish were highly migratory, and exhibited seasonal differences in use of the Missouri River and Yellowstone River. Blue suckers tended to be less migratory. In September 2002, an additional 21 shovelnose sturgeon, 21 blue suckers, and 3 paddlefish were implanted with transmitters. These individuals will be tracked during 2003. A total of 41,768 larval fish were sampled at six sites on the mainstem Missouri River and adjacent habitats. Larval sturgeon (*Scaphirhynchus* sp.) were sampled at Wolf Point (N = 5) and in the Yellowstone River (N = 9). Larval catostomids (suckers) were the dominant taxon sampled, and comprised 43-94% of the larval fishes sampled at all sites; however, taxa composition varied significantly among sites. Food habit data for burbot *Lota lota*, channel catfish *Ictalurus punctatus*, freshwater drum *Aplodinotus grunniens*, goldeye

Hiodon alosoides, northern pike *Esox lucius*, sauger *Stizostedion canadense*, shovelnose sturgeon, and walleye *Stizostedion vitreum* were obtained during July and August 2001. All species with the exception of shovelnose sturgeon exhibited piscivory, but there was no evidence that sturgeon larvae or juveniles were consumed. Six hatchery-raised juvenile pallid sturgeon and one adult pallid sturgeon were sampled during September in conjunction with associated field activities. In addition, two larval pallid sturgeon (21.6 mm, 23.1 mm) were sampled on September 4 and 5, 2002, downstream from the Yellowstone River confluence. These findings are the first documented account of larval pallid sturgeon in the Missouri River downstream from Fort Peck Dam, and indicate that successful spawning by pallid sturgeon did occur in 2002. However, it is not known whether spawning occurred in the Yellowstone River or in the Missouri River.

Introduction

The U.S. Army Corps of Engineers (USACE) proposes to modify operations of Fort Peck Dam following specifications outlined in the Missouri River Biological Opinion (U.S. Fish and Wildlife Service 2000). Modified dam operations are proposed to increase discharge and enhance water temperatures during late May and June to provide spawning cues and enhance environmental conditions for pallid sturgeon *Scaphirhynchus albus* and other native fishes. In contrast to "normal" cold water releases through Fort Peck Dam, water from Fort Peck Reservoir will be released over the spillway during flow modifications to enhance water temperature conditions. The USACE proposes to conduct a mini-test of the flow modification plan to evaluate structural integrity of the spillway and other engineering concerns. A full-test of the flow modifications will occur when a maximum of 19,000 cfs will be routed through the spillway. Spillway releases will be accompanied by an additional 4,000 cfs released through the dam. Pending results from the full-test, modified flow releases from Fort Peck Dam in subsequent years will be implemented in an adaptive management framework. All proposed flows are dependent on adequate inflows to Fort Peck Reservoir and adequate water levels in the reservoir.

The original schedule of events for conducting the flow modifications called for conducting the mini-test during 2001 and conducting the full-test in 2002. However, insufficient water levels in Fort Peck Reservoir during spring 2001 and 2002 precluded conducting the mini-test and full-test. Thus, pending favorable precipitation and adequate reservoir water levels in early spring 2003, the mini-test may be conducted in 2003 and the full-test conducted in 2004.

The Fort Peck Flow Modification Biological Data Collection Plan (hereafter referred to as the Fort Peck Data Collection Plan) is a monitoring program designed to examine the influence of proposed flow modifications from Fort Peck Dam on physical habitat and biological response of pallid sturgeon and other native fishes. Components of the monitoring program include: 1) measuring water temperature and turbidity at several locations downstream from Fort Peck Dam, 2) examining movements by pallid sturgeon that inhabit areas immediately downstream from Fort Peck Dam, 3) examining flow- and temperature-related movements of paddlefish *Polyodon spathula*, blue suckers *Cycleptus elongatus*, and shovelnose sturgeon *Scaphirhynchus platorynchus*, 4) quantifying larval fish distribution and abundance, and 5) examining food habits of piscivorous fishes. The Fort Peck Data Collection Plan is supported by the USACE, and implemented by the Montana Department of Fish, Wildlife, and Parks (MTFWP) and the U. S. Geological Survey Columbia Environmental Research Center – Fort Peck Project Office. Western Area Power Administration serves as the contractual liaison between the USACE and MTFWP.

Study Area

The Missouri River study area extends from Fort Peck Dam located at river kilometer (rkm) 2,850 (river mile, RM 1,770) to the headwaters of Lake Sakakawea near rkm 2,496 (RM 1,550; Figure 1). The study area also includes the lower 113 rkm (70 miles) of the Yellowstone River (Figure 1). See Gardner and Stewart (1987), White and Bramblett (1993), Tews (1994), and Bramblett and White (2001) for a complete description of physical and hydrological characteristics of the study area.

Methods

Monitoring Component 1 - Water temperature and turbidity.

Water temperature logger deployment. Water temperature loggers (Optic StowAway, -5°C – +37°C, 4 min response time, accuracy ± 0.2°C from 0 - 21°C) were deployed during early May at sites in the Missouri River, Yellowstone River, selected tributaries, and off-channel areas (Table 1). Duplicate loggers were secured adjacent to the north and south bank lines at sites in the Missouri River to assess lateral variations in water temperature. Water temperature loggers were positioned near the bottom of the river channel. An additional logger was stratified in the water column at selected sites to assess vertical variations in water temperature. Stratified water temperature loggers were secured to either the north or south bank locations. Water temperature loggers were programmed to record water temperature at 1-hr intervals, and periodically downloaded during the deployment period.

Statistical analysis of water temperature. Analysis of variance and t-tests were used to compare mean daily water temperature among water temperature loggers positioned on the north and south bank locations, and stratified in the water column. Analysis of variance was used to compare mean daily water temperature among all logger locations.

Assessment of water temperature logger precision. Precision of water temperature loggers was assessed prior to and following retrieval from the field. In April 2002, all water temperature loggers (except the logger deployed at Robinson Bridge) were subjected to a series of 15 common water bath treatments to evaluate precision and accuracy among loggers. The 15 water bath treatments were comprised of three temperature ranges (cold, < 10°C; cool, 15-20°C; warm, > 20°C) with five temperature measurements recorded within each temperature range. During water bath treatments, water temperature was also measured with a YSI Model 85 meter (accuracy ± 0.1°C) and a hand-held alcohol thermometer (accuracy ± 1.0°C) at specific times. In late November following retrieval from the field, water temperature loggers were subjected to a similar series of common water bath treatments as conducted in pre-deployment assessments. In addition to pre- and post-deployment comparisons involving water bath treatments, water temperature measured with the YSI Model 85 meter during the course of larval fish sampling (late May through early August, see below) provided an additional data set to which accuracy and precision of the loggers could be evaluated. Larval fish sampling sites were generally within 1.6-3.2 km (1-2 miles) of a water temperature logger. Water temperature at the larval fish sampling sites was measured in the upper 1-m of the water column.

Statistical analysis of water temperature logger precision. Pre- and post-deployment precision of loggers for each water bath treatment was evaluated with univariate statistics (mean, standard deviation, minimum, maximum, and range) computed over all loggers. The mean, minimum, maximum, and range were screened for precision. If precision was low (e.g., broad range of temperature for an individual water bath trial), logger data were scrutinized to determine which logger(s) was contributing to the extreme values. After identifying and deleting the "suspect" logger(s), univarite statistics were computed again to assess precision. In addition to univariate statistics, a two-way analysis of variance was used to compare precision (i.e., temperature range) of water temperature loggers between pre- and post-deployment test and among the three water temperature treatments.

Figure 1. Missouri River below Fort Peck Dam. The Yellowstone River enters the Missouri River at river mile 1,582.

Table 1. Sites, approximate river mile (RM; distance upstream from the Missouri River-Mississippi River confluence or distance upstream in a specified tributary), bank locations (north, south, strat = stratified in the water column), serial numbers, and dates of deployment for water temperature loggers deployed in the Missouri River and adjacent areas during 2002. NR = not recovered at the end of the season.

Site	RM	Bank location	Logger serial no.	Deploy date	Retrieval date
Above Fort Peck Lake	1,921.2	South		4/26/02	11/6/02
Downstream from Fort Peck Dam	1,765.2	North	389503	5/10/02	10/21/02
		South	389561	5/10/02	10/21/02
Spillway			389574	5/10/02	10/21/02
Milk River	4.0		389560	5/9/02	10/21/02
Nickels Ferry	1,759.9	North	389495	5/9/02	10/21/02
		South	389488	5/9/02	10/21/02
		strat	407322	5/9/02	10/21/02
Nickels Rapids	1,757.5	North	389563	5/9/02	11/6/02
		South	389571	5/9/02	11/6/02
		strat	389504	5/9/02	11/6/02
Frazer Pump	1,751.5	North	389565	5/9/02	11/6/02
		South	389489	5/9/02	11/6/02
		Strat	389556	5/9/02	11/6/02
Frazer Rapids	1,746.0	North	389501	5/9/02	11/6/02
		South	389490	5/9/02	11/6/02
		Strat	429705	5/9/02	11/6/02
Grand Champs	1,741.5	North	389497	5/9/02	11/6/02
		South	389575	5/9/02	11/6/02
		Strat	407323	5/9/02	11/6/02
Wolf Point	1,701.5	North	389493	5/9/02	11/6/02
		South	389500	5/9/02	11/6/02
		strat	429703	5/9/02	11/6/02
Redwater River	0.1		389502	5/9/02	NR
Poplar	1,680	North	389491	5/9/02	NR
		South	389492	5/9/02	NR
		strat	429700	5/9/02	NR
Poplar River	0.4		314955		NR
Culbertson	1,620.9	North	389572	5/2/02	10/25/02
		South	389567	5/2/02	NR
		strat	429696	5/2/02	10/25/02
Nohly	1,591.2	North	429697	5/1/02	11/8/02
		South	389498	5/1/02	NR
		strat	429698	5/1/02	NR
Yellowstone River	3.5		389562	5/1/02	11/8/02
Below Yellowstone River	1,576.5	North	389566	5/1/02	11/8/02
		South	389564	5/1/02	11/8/02
		strat	429704	5/1/02	11/8/02

Field measurements of turbidity. Turbidity (nephelometric turbidity units; NTU) was measured from late May through August with continuous-recording (1-hr interval) turbidity data loggers (Hydrolab Datasonde 4a, serial numbers 39046, 39047, 39048, 39049, measurement range 0 – 1000 NTU, accuracy $\pm$ 2%). Turbidity loggers were deployed in the Missouri River near Frazer Rapids (rkm 2,811; RM 1,746), near Poplar (rkm 2,708; RM 1,682) and near Nohly (rkm 2,558; RM 1589), and in the Yellowstone River 0.81 km (0.5 miles) upstream from the confluence.

A*ssessments of turbidity logger precision.* Precision of turbidity loggers was assessed during field deployment and following retrieval from the field. Turbidity loggers at Nohly and in the Yellowstone River were located within larval fish sampling stations (see below) where turbidity was also measured at 2-3 day intervals between late May and early August. Turbidity at the larval fish sampling stations was meausred using a Hach Model 2100P portable turbidimeter (measurement range 0 – 1000 NTU, accuracy $\pm$ 2%). Thus, time- and date-specific turbidity measurements logged by the turbidity loggers were compared to turbidities measured during larval fish sampling. After deployment in the field, turbidity loggers were subjected to a common water bath to assess precision of turbidity measurements among the turbidity loggers. The loggers were placed in a water bath to which sediment had been added. Sediments in the bucket were periodically mixed to increase turbidity. After turbidity declined due to particle settling, the sediments were again stirred to increase turbidity. Turbidity loggers were programmed to record turbidity at 15-min intervals during the post-deployment assessments. The 15-min sampling interval resulted in more than 90 individual measurements of turbidity during the post-deployment tests. A subsample of low (< 100 NTU), medium (200-500 NTU), and high (>500 NTU) turbidity measurements was randomly selected from the total number of observations for post-deployment comparisons.

Statistical analysis of turbidity logger precision. Correlation analysis was used to assess the degree of association between turbidities measured by the turbidity loggers and turbidities measured during larval fish sampling at Nohly and in the Yellowstone River. In addition, t-tests were used to compare mean turbidity recorded by the loggers and during larval fish sampling. For post-deployment assessments of turbidity, univariate statistics as calculated for water temperature (discussed above) were screened for precision. Analysis of variance was used to compare the turbidity range (i.e., precision) among low, medium, and high turbidity water bath treatments.

Monitoring Component 2 – Movements by pallid sturgeon.

Diving in areas immediately downstream from Fort Peck Dam was conducted periodically during a 6-week period in February and March 2001. Pallid sturgeon collected were to be implanted with transmitters and tracked during spring and summer 2002.

Monitoring Component 3 – Flow- and temperature-related movements of paddlefish, blue suckers, and shovelnose sturgeon.

Transmitter implantation.-Sampling for paddlefish, blue suckers, and shovelnose sturgeon for transmitter implantation was conducted in September 2002. Species were sampled using drifted trammel nets, hoop nets (primarily targeting blue suckers), and surface-drifted gill nets (primarily targeting paddlefish). A minimum of 20 suitable-sized individuals of each species were targeted for transmitter implantation. Our goal was to extend flow- and temperature-related movement inferences to all areas of the Missouri River below Fort Peck

Dam. Therefore, species were collected in several areas between rkm 2,842 (RM 1,765) and rkm 2,547 (RM 1,582; Figure 1).

The three species were implanted with two varieties of combined acoustic/radio tags (CART tags, Lotek Wireless Incorporated, New Market, Ontario). The CART tag emits alternating radio and acoustic coded signals at established time intervals. The coded signal emitted by each CART tag is unique to facilitate identification of individual fish. Blue suckers and shovelnose sturgeon were implanted with the CART 16-2S (16 mm x 68 mm, air weight = 31.5 g, 865-day longevity, 4-second pulse interval, 149.620 Mhz, 76.8 kHz). Paddlefish were implanted with the CART 32-1S (32 mm x 101 mm, air weight = 114 g, 1,095-day longevity, 1 second interval, 149.620 MHz, 76.8 kHz).

Surgical implantation of transmitters was conducted after 1-6 individuals were captured at a sampling location. After being sampled, fish were placed in streamside live cars. Individuals were placed in a partially submerged V-shaped trough during surgical implantation of transmitters, and water was continually flushed water over the gills using a bilge pump apparatus. After making an abdominal incision about midway between the pectoral fin and pelvic fin, a shielded needle technique (Ross and Kleiner 1982) was used to extrude the transmitter antennae through the body cavity. The transmitter was then inserted into the body cavity, and the incision was closed with silk sutures. Most blue suckers and shovelnose sturgeon were held overnight in streamside live cars, and released the following morning. A 5-10 minute period of facilitated acclimation following surgical procedures was used to stabilize paddlefish prior to release. Surgical implantation of transmitters was conducted at water temperatures between was 10.3^{o}C and 16.4^{o}C.

Stationary telemetry logging stations.- Stationary telemetry logging stations were deployed in late April and early May 2002 at six sites (Milk River, RM 2.0; downstream from the Milk River, RM 1,759; near Wolf Point, RM 1,717; near Poplar, RM 1,681.5; near Brockton, RM 1,651; near Culbertson, RM 1,619). The logging stations (8 ft x 8 ft floating platform) were positioned away from the bankline, and secured to the bankline using cables and an iron arm. Each logging station was equipped with unidirectional hydrophones (one pointing upstream, one pointing downstream), solar panels, and an environmental enclosure kit containing dual 12-volt batteries, a receiver, two ultrasonic upconverters, and an antennae switchbox.

Manual tracking of implanted fish.- Manual tracking of fish implanted with CART tags in September 2001 was initiated in April 2002. The Missouri River between Fort Peck Dam and the headwaters of Lake Sakakawea (354 km, 220 miles), and the Yellowstone River from the confluence to Intake Diversion (113 km, 70 miles) were tracked at about weekly intervals. Two radio frequencies (149.760 MHz, 149.620 MHz) were simultaneously monitored during the boat-tracking run. A hydrophone was used to scan acoustic frequencies in deep areas of the two rivers. The entire study area could be tracked in a 3-4 day time interval. Several variables (frequency, code, latitude, longitude, river mile, water depth, habitat type, water temperature, turbidity, time-of-day) were recorded at fish relocations.

Data analysis.-A complete analysis of fish movements and tracking data is not warranted at this time because 2002 was the initial year of the multi-year study. Rather, fish movements and tracking data for 2002 were summarized for the study period as the number of relocations per km by river reach for the three species. Five river reaches were delineated, and included Reach 1 (Fort Peck Dam to Wolf Point, rkm 2,832 – rkm 2,723), Reach 2 (Wolf Point to the Yellowstone River confluence, rkm 2,723 – km 2,691), Reach 3 (Yellowstone River confluence to Highway 85 near Williston, ND, rkm 2,691 – rkm 2,485), Reach 4 (Yellowstone River from the confluence to Sidney, MT, rkm 0 – rkm 48), and Reach 5 (Yellowstone River from Sidney to Intake diversion dam, rkm 48 – rkm 114).

<u>Monitoring Component 4 – Larval Fish</u>

Sampling protocols. Larval fish were sampled at about 3-4 day intervals from late May through early August at six sites (Table 2). Similar to 2001, sites on the mainstem Missouri River were located just downstream from Fort Peck Dam, near Wolf Point, and near Nohly. Sites located off the mainstem Missouri River included the spillway channel, the Milk River, and the Yellowstone River. Larval fish at all sites were sampled with 0.5-m-diameter nets (750 µm mesh) fitted with a General Oceanics Model 2030R velocity meter.

Table 2. Larval fish sampling locations, number of replicates, samples, and net locations for 2002. Abbreviations for net location are as follows: B = bottom, M = mid-water column, S = surface (0.5 - 1.0 m below the surface).

Site	Approximate river mile	Replicates	Samples per replicate	Net location
Missouri River below Fort Peck Dam	1,763.5-1,765.3	3	4	B/M
Spillway	1,762.8	2	4	S
Milk River	0.5-4.0	5	4	S
Missouri River near Wolf Point	1,701.0-1,708.0	5	4	B/M
Missouri River near Nohly	1,584-1,592	5	4	B/M
Yellowstone River	0.1-3.0	5	4	B/M

Specific larval fish sampling protocols varied among sites and were dependent on site characteristics (Table 2). Two to five replicates were collected at the sites, where one replicate was comprised of four subsamples (two subsamples simultaneously collected on the right and left side of the boat at sampling locations near the left and right shorelines). At all sites except the spillway site, the left and right sampling locations corresponded to inside bend and outside bend locations at the mid-point of a river bend. The spillway channel had minimal sinuosity; therefore, samples did not reflect inside and outside bend locations. Only two replicates were available in the spillway channel (one replicate in both of the spillway channel pools), and three replicates were available at the site downstream from Fort Peck Dam. The full compliment of five replicates was available at the other sites. At sites exclusive of the spillway and Milk River, paired subsamples near the left and right bank locations were comprised of one net fished on the bottom and one net fished in the middle of the water column. Thus, each replicate was comprised of two bottom subsamples and two mid-water column subsamples. Nets were maintained at the target sampling location by affixing lead weights to the net. Larval nets were fished for a maximum of 10 minutes (depending on detrital loads). The boat was anchored during net deployment (e.g., “passive” sampling). In the Milk River and spillway channel, irregular bottom contours, shallow depths, and silt substrates were not conducive to bottom sampling. In addition, minimal current velocity in these two locations required an “active” larval fish sampling approach. Therefore, larval fish in the Milk River and spillway channel were sampled in the upper 1-m of the water column as the boat was powered upstream for a maximum of 10 min. Larval fish samples were placed in a 5-10% formalin solution containing phloxine-B dye and stored.

Larval fish were sampled at the same replicate and subsample locations throughout the sampling period except when changes in discharge necessitated minor adjustments in the sampling location. For example, an attempt was made to sample larval fish at total water column depths between 1.5 m and 3.0 m. This protocol was used to minimize variations in larval fish density associated with vertical stratification of larvae in the water column. When river discharge decreased (or increased), water depth in a previously sampled location exceeded the required range. Therefore, the specific sampling location changed but was always near (± 300 m) the general vicinity of the earlier samples.

Laboratory methods. Larval fish were extracted from samples and placed in vials containing 70% alcohol. Larvae were identified to family when possible and enumerated. Damaged individuals that could not be identified were classified as unknown.

Changes in larval fish sampling protocols from 2001. Three sampling protocols were changed between 2001 (first year of the project) and 2002. First, the maximum number of replicates was increased from three (2001) to five (2002) for the Milk River, Yellowstone River, and Missouri River sites located near Wolf Point and Nohly. At the site downstream from the dam, the number of replicates was increased from two (2001) to three (2002). The number of replicates in the spillway channel was not increased because there are only two pools. Second, sample duration was decreased from a maximum of 15 min (2001) to 10 min (2002). Thus, although maximum sample duration was reduced in 2002, an increase in the number of replicates actually increased the total sampling time (see Results). Third, larval fish sampling extended to the first week of August in 2002; whereas, larval fish sampling was concluded the last week of July in 2001.

Monitoring Component 5 – Food habits of piscivorous fishes

Potential piscivores including walleye *Stizostedion vitreum*, sauger *S. canadense*, northern pike *Esox lucius*, burbot *Lota lota*, goldeye *Hiodon alosoides*, channel catfish *Ictalurus punctatus*, freshwater drum *Aploninotus grunniens*, and shovelnose sturgeon were sampled in the Missouri River between Wolf Point and Nohly (Figure 1). Fishes were sampled during July and August 2002 in off-channel habitats (e.g., tributaries, tributary confluences, backwaters, side channels) and main channel habitats (e.g., outside bend shoreline and thalweg, inside bend shoreline and channel border, channel crossovers) using stationary gill nets, drifting trammel nets, hoop nets, and electrofishing. Gill nets and hoop nets were usually set in late afternoon or evening and checked the following morning, but in some instances both gear types were left in a location throughout the day and periodically checked. Fishes were identified, weighed (g), and measured (mm).

Stomach samples were obtained in one of two ways. First, the entire stomach was removed via dissection and placed in a 10% formalin solution for storage. In the case of large stomachs, a slit was made in the stomach wall to facilitate formalin seepage into the stomach. The second method of stomach sampling involved the use of gastric lavage. The lavage apparatus consisted of a 12-V bilge pump connected to plastic hose. With the bilge pump operating and the fish held in a slightly inverted position, the hose was inserted down the esophagus of the fish and into the fish stomach. Running water flushed contents of the stomach into a sieve held under the fish mouth and gills. Stomach contents were rinsed from the sieve into a 10% formalin solution and stored. The lavage was used on sauger sampled to minimize mortality because sauger are listed as a species of special concern in Montana.

In the laboratory, stomach contents were initially identified to Class. Diet organisms were subsequently identified to Order (for Insecta) and to species (for Osteichthyes) when possible. Diet items that could not be identified beyond Insecta and Osteichthyes were designated as unknown for the Class. Diet items were also classified as detritus (e.g., woody debris, algae) and miscellaneous (e.g., sand, rocks). Diet items were enumerated and weighed for the lowest taxon identified. Wet weights (0.001 g) were measured after the diet items were blotted on paper towels to remove excess water. Body fragments were used to enumerate organisms. For example, the presence of a head capsule or partial body fragment was treated as indicative of a whole organism. For Osteichthyes, fish scales, bones or the presence of other body parts was treated as indicative that a whole organism was ingested.

Food habits data were summarized by three indices. Frequency of occurrence (%) was calculated as the number of individuals containing the specific food item/number of stomachs containing food. Numerical frequency (%) was computed as the total number of taxon-specific food items/total number of all food items. Weight frequency (%) was computed as the total weight of a taxon-specific food item/total weight of all food items.

Results and Discussion

Monitoring Component 1 - Water temperature and turbidity

General comments on water temperature loggers. Of the 38 water temperature loggers deployed during 2002, eight (21%) were not recovered. These included all three loggers deployed at Poplar, single loggers deployed in the Poplar River and Redwater River, one logger deployed at Culbertson, and two loggers deployed at Nohly. Excessive sedimentation and accumulation of woody debris prevented these loggers from being retrieved. With the exception of the Poplar site, at least one logger was recovered from Culbertson and Nohly thereby providing water temperature data at these sites. On September 5, it was observed that the water temperature logger in the Yellowstone River was in less than 15 cm of water. Subsequent checks of the data indicated large diel variations in water temperature during August and the first few days of September. These large diel variations most likely resulted from diel variations in air temperature rather than water temperature. Data for August was “corrected” by replacing the suspect temperature logger data with hourly water temperature data recorded by the Yellowstone turbidity logger located just downstream from the temperature logger.

Pre- and post-deployment assessments of water temperature logger precision. A total of 36 loggers was assessed for precision during the pre-deployment tests (Table 3). For all water temperature treatments during pre-deployment tests, the temperature range (i.e., maximum recorded temperature minus minimum recorded temperature) was narrow (≤ 0.66°C; Table 3) indicating that precision of the loggers was good. For the post-deployment tests, only 26 loggers were screened for precision due to exclusion of loggers that were not recovered at the end of the deployment period. Post-deployment assessments of precision indicated that precision of the water temperature loggers remained good as evidenced by a narrow temperature range (≤ 0.71°C) for all treatment temperatures (Table 3). Pre- and post-deployment comparisons indicated there was no significant difference ($F = 0.46$, $P = 0.64$, df = 2, 24) in water temperature range (i.e., precision) among the cold (mean = 0.53°C), cool (mean = 0.51°C), and warm

($0.55^{o}C$) water temperature treatments. Thus, pre- and post-deployment precision was consistent among the different water temperature treatments. However, the range differed significantly between the pre- and post-deployment tests ($F = 4.86$, $P = 0.04$, $df = 1, 24$). Pooled across water temperature treatments, the range was significantly greater for the post-deployment tests (mean = $0.56^{o}C$) than the pre-deployment tests (mean = $0.50^{o}C$). These results suggest some "drift" of precision following deployment in the field. However, the difference in precision between pre- and post-deployment tests was minimal ($0.06^{o}C$) suggesting that the quality of water temperature data recorded by the loggers was still good. There was no significant ANOVA interaction term ($P = 0.39$). Results from the pre- and post-deployment tests suggest that the water temperature data recorded by the loggers at all sites during 2002 accurately depicted thermal conditions in the riverine areas.

Lateral and vertical comparisons of water temperature. There were 11 sites where water temperature loggers were positioned on the north and south banks, and stratified in the water column (Table 1). However, comparisons of water temperature among north bank, south bank, and stratified locations could only be conducted at nine sites due to the loss of loggers at the Poplar and Nohly. At the site located just downstream from Fort Peck Dam, there was no significant difference in water temperature between the north and south bank locations (Table 4). At the Nickels Ferry site, water temperature was significantly greater on the north bank and stratified location than on the south bank. The stratified logger at Nickels Ferry was positioned on the north bank along with the north bank logger. Lack of a significant difference between stratified and north bank logger indicates homeothermal conditions through the water column. Significant differences in water temperature occurred at the Nickels Rapids site where water temperature was greatest on the north bank and stratified location and least on the south bank. At the Nickels Rapids site, the stratified logger was positioned on the south bank along with the south bank logger. Lack of a significant difference between stratified and south bank logger indicates homeothermal conditions through the water column. No significant differences in water temperature among logger locations occurred at the Frazer Pump site, Frazer Rapids site, Grand Champs site, or Culbertson Site (Table 4). Similar to the Nickels Ferry and Nickels Rapids site, lack of significant differences in water temperature between stratified and either north or south bank locations at these sites indicate homeothermal conditions in the water column. At the site located downstream from the Yellowstone River, water temperature was significantly greater at the stratified and south bank locations than at the north bank location. However, there is some indication that water temperatures recorded by the north bank logger at this site were not representative of "true" water temperatures. For example, mean water temperature was higher at Nohly than at the north bank logger located downstream from the Yellowstone River. One would expect that water temperature at this site should be at least equal to or greater than water temperatures recorded at Nohly. Based on this consideration, the logger located on the north bank downstream from the Yellowstone River was likely recording slightly cooler ground water seepage than ambient river temperatures. Similar to the other sites, there was no significant difference between the stratified logger positioned on the south bank and the south bank logger located at the site downstream from the Yellowstone River.

Table 3. Pre- and post-deployment summary statistics for water temperature comparisons among YSI Model 85 meter (YSI), hand-held alcohol thermometer (Alcohol), and water temperature loggers in common water bath treatments.

Sample	YSI	Alcohol	Logger mean	Logger minimum	Logger maximum	Logger range	Logger SD	Number of loggers
				Pre-deployment				
1	17.8	18.0	17.6	17.3	17.8	0.45	0.10	36
2	17.9	18.0	17.7	17.5	17.9	0.44	0.10	36
3	18.0	18.0	17.7	17.5	17.9	0.45	0.10	36
4	18.0	18.0	17.8	17.6	18.1	0.49	0.10	36
5	18.0	18.0	17.9	17.6	18.1	0.44	0.09	36
6	3.1	3.0	3.0	2.8	3.2	0.41	0.10	36
7	3.2	3.0	3.1	2.8	3.4	0.55	0.11	36
8	3.3	3.0	3.3	3.0	3.6	0.55	0.11	36
9	3.3	3.0	3.2	3.0	3.6	0.55	0.11	36
10	3.4	3.0	3.4	3.2	3.6	0.43	0.10	36
11	25.0	24.0	25.1	24.8	25.4	0.66	0.13	36
12	23.8	23.0	23.9	23.6	24.2	0.65	0.13	36
13	22.9	23.0	22.9	22.7	23.2	0.46	0.10	36
14	21.9	22.0	22.1	21.9	22.3	0.47	0.11	36
15	21.4	21.0	21.5	21.2	21.7	0.46	0.11	36
				Post-deployment				
1			7.2	6.9	7.5	0.55	0.11	26
2			7.2	6.9	7.5	0.55	0.10	26
3			7.3	7.1	7.6	0.55	0.12	26
4			7.5	7.2	7.6	0.43	0.09	26
5	8.1	8.0	7.6	7.2	7.9	0.71	0.16	26
6	20.9	22.0	21.7	21.4	22.0	0.64	0.13	26
7			21.2	20.9	21.5	0.63	0.12	26
8			20.8	20.6	21.0	0.46	0.12	26
9			20.4	20.1	20.7	0.61	0.13	26
10			20.2	19.9	20.4	0.45	0.12	26
11			18.5	18.3	18.7	0.45	0.12	26
12			18.5	18.1	18.7	0.61	0.13	26
13			18.5	18.1	18.7	0.61	0.13	26
14			18.5	18.1	18.7	0.60	0.13	26
15	18.6	18.0	18.5	18.1	18.7	0.60	0.13	26

Table 4. Summary statistics and probability values (P, from ANOVA or t-tests) for comparisons of mean daily water temperature (°C) among water temperature loggers located on the north bank and south bank, and stratified in the water column during 2002. Means with the same superscript within sites are not significantly different (P > 0.05). Inclusive dates for comparisons at all sites are 5/11/02-10/20/02 (163 days).

Site	Logger location	Mean	SD	Minimum	Maximum	P
Below Fort Peck Dam	North	12.0 [a]	2.3	5.8	15.5	0.53
	South	11.8 [a]	2.2	5.8	15.3	
Nickels Ferry	North	13.2 [a]	3.0	6.1	21.7	0.0007
	South	12.2 [b]	2.3	6.1	15.8	
	Stratified	13.2 [a]	3.0	6.1	21.8	
Nickels Rapids	North	13.0 [a]	2.7	6.4	19.7	0.02
	South	12.3 [b]	2.3	6.3	16.0	
	Stratified	12.4 [a,b]	2.3	6.3	16.1	
Frazer Pump	North	13.1 [a]	2.7	7.0	18.9	0.11
	South	12.6 [a]	2.4	6.7	16.5	
	Stratified	13.1 [a]	2.7	6.9	18.9	
Frazer Rapids	North	12.7 [a]	2.6	6.6	18.0	0.53
	South	12.8 [a]	2.4	6.8	16.7	
Grand Champs	North	13.0 [a]	2.5	7.1	18.0	0.94
	South	13.1 [a]	2.5	7.4	17.0	
	Stratified	13.1 [a]	2.5	7.4	16.9	
Wolf Point	North	14.4 [a]	2.9	9.1	19.2	0.75
	South	14.6 [a]	3.3	7.9	19.8	
Culbertson	North	16.2 [a]	4.1	8.1	23.4	0.80
	Stratified	16.3 [a]	4.6	7.1	24.5	
Nohly	North	16.7	4.8	6.7	25.4	
Below Yellowstone River	North	15.8 [b]	3.8	6.5	21.6	0.0001
	South	17.8 [a]	5.1	6.7	27.2	
	Stratified	17.9 [a]	5.2	6.7	27.3	

Influence of tributary inflows on water temperature. Lateral differences in water temperature at some sites suggested that tributary inflows differentially influenced water temperatures on north and south bank locations due to incomplete lateral mixing. During 2002, the Milk River exhibited periods of increasing and decreasing flows between mid- and late-June, and during late August. During these time frames, water temperatures on the north bank of the river at Nickels Ferry, Nickels Rapids, Frazer Pump, Frazer Rapids, and Grand Champs increased and decreased with Milk River flows; whereas, water temperatures on the south bank of the river remained relatively stable (Figures 2, 3, 4). The influence of Milk River discharge on lateral differences in water temperature is also demonstrated by significant positive correlations between the difference in mean daily water temperature between the north and south banks (north bank minus south bank) and Milk River discharge at Nickels Ferry ($r = 0.85$, $P < 0.0001$, $N = 90$), Nickels Rapids ($r = 0.83$, $P < 0.0001$, $N = 90$), Frazer Pump ($r = 0.79$, $P < 0.0001$, $N = 90$), Frazer Rapids ($r = 0.81$, $P < 0.0001$, $N = 90$), and Grand Champs ($r = 0.84$, $P < 0.0001$, $N = 90$). The maximum difference in water temperature between the north and south banks decreased from upstream to downstream and was 8.1^{o}C at Nickels Ferry, 5.5^{o}C at Nickels Rapids, 3.5^{o}C at Frazer Pump, 1.8^{o}C at Frazer Rapids, and 1.1^{o}C at Grand Champs (Figures 2, 3, 4). Thus, lateral mixing of Milk River water and Missouri River water discharged through Fort Peck Dam was nearly complete at the Grand Champs site.

Earlier studies in the Missouri River downstream from Fort Peck have evaluated lateral variations in water temperature resulting from Milk River discharge inputs. Braaten and Fuller (2002) found that mean daily water temperature did not differ significantly between north and south bank locations for the time period spanning early May through October; however, there were specific instances when bank locations deviated in water temperature as a result of warm discharge inputs from the Milk River. Gardner and Stewart (1987) and Yerk and Baxter (2001) similarly showed that warm inputs from the Milk River differentially affected lateral water temperatures, but the effects are most pronounced in spring and early summer when Milk River discharge is high.

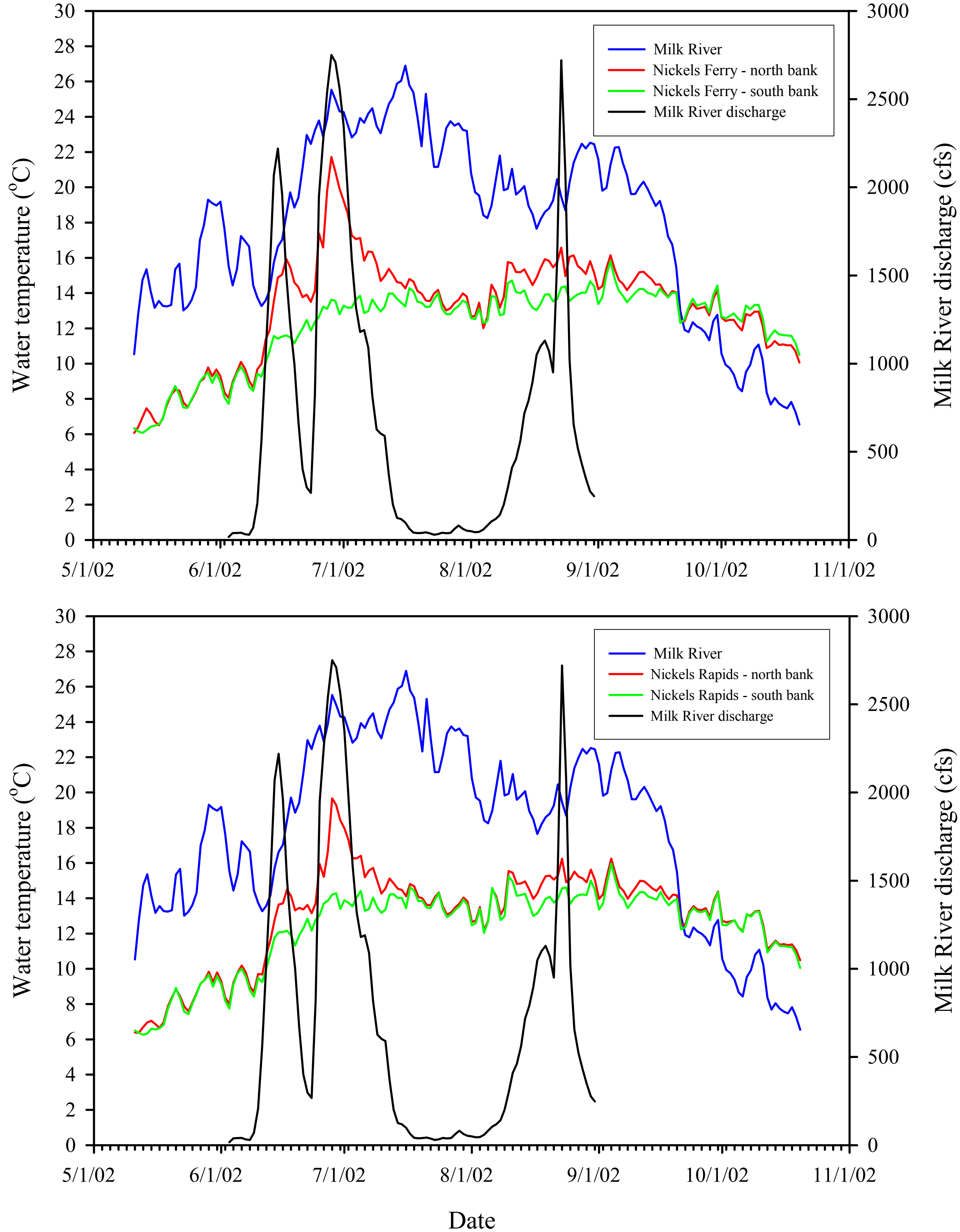


Figure 2. Water temperature profiles and discharge for the Milk River, and water temperatures profiles for the Missouri River at Nickels Ferry and Nickels Rapids during 2002.

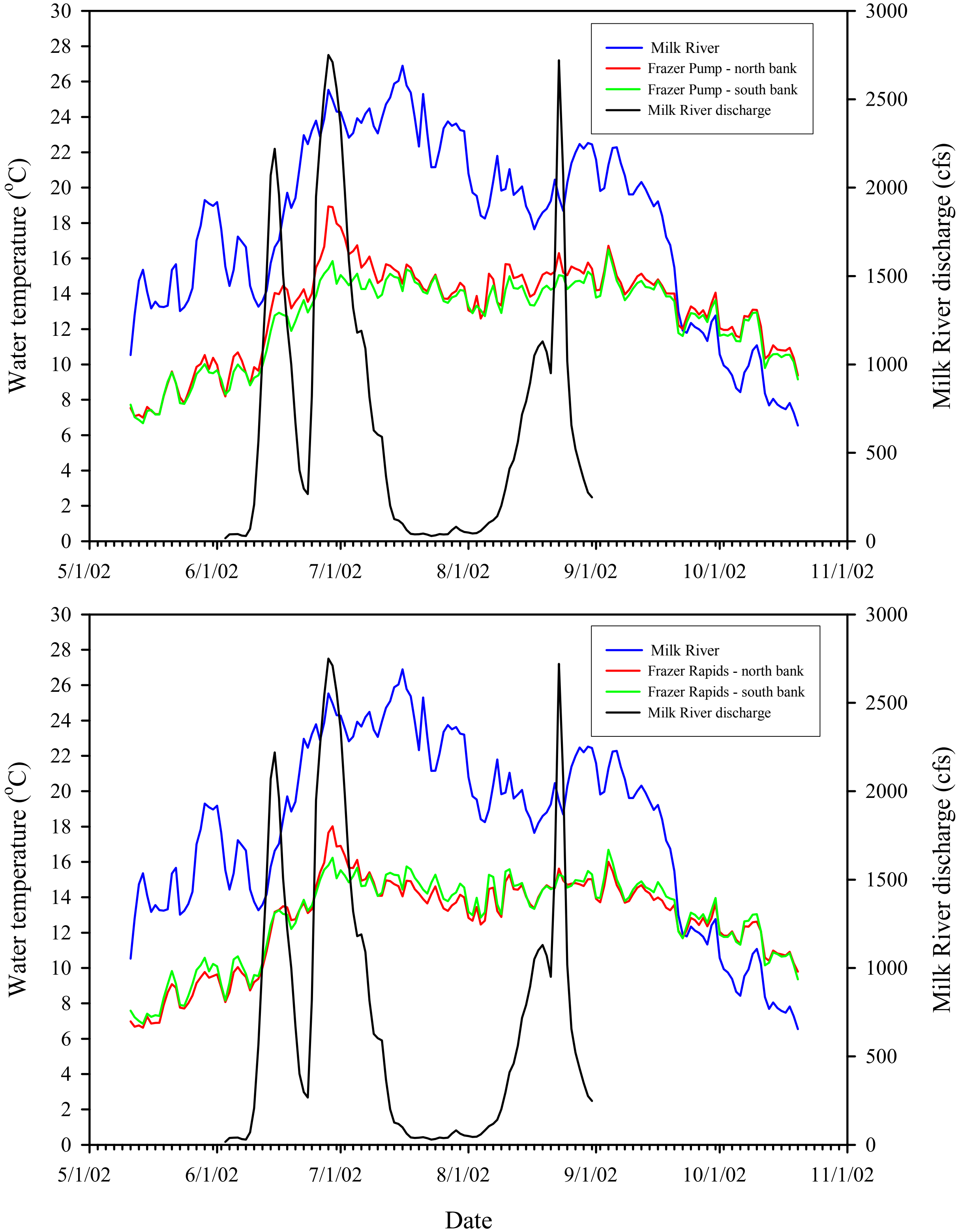


Figure 3. Water temperature profiles and discharge for the Milk River, and water temperatures profiles for the Missouri River at Frazer Pump and Frazer Rapids during 2002.

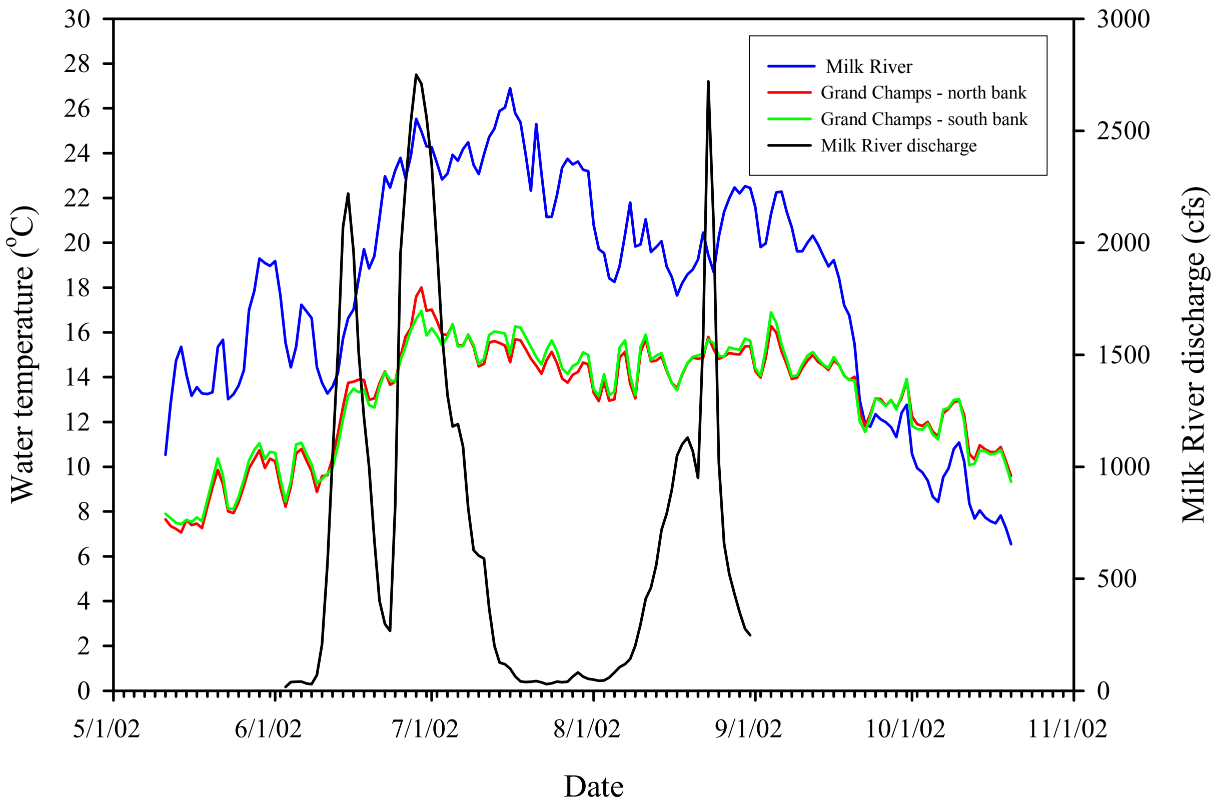


Figure 4. Water temperature profiles and discharge for the Milk River, and water temperatures profiles for the Missouri River at Grand Champs during 2002.

Longitudinal water temperature patterns. Daily water temperature for all sites was averaged across north bank, south bank, and stratified locations to depict average thermal conditions in the river. Mean water temperature for the common deployment period (5/11/02-10/20/02) differed significantly among the 11 Missouri River mainstem sites and three off-channel locations (ANOVA, $F = 64.35$, $df = 13, 2,268$, $P < 0.0001$; Table 5, Figure 5). Mean daily water temperature for Missouri River mainstem sites was greatest at the Robinson Bridge site (17.9°C) located in the free-flowing reach of the Missouri River upstream from Fort Peck Lake and in the Missouri River downstream from the Yellowstone River (17.9°C). The lowest mean daily water temperature occurred at the site just downstream from Fort Peck Dam (11.9°C). Mean daily water temperature increased downstream from Fort Peck Dam, and was 16.7°C at the Nohly site. Daily water temperature at the Missouri River mainstem locations was most variable in the Missouri River below the Yellowstone River confluence (CV = 28.8) and at Nohly (CV = 28.7), but lease variable just downstream from Fort Peck Dam (CV = 11.9; Table 5). The USFWS (2000) mandated that a minimum water temperature of 18°C be established and maintained at Frazer Rapids (rkm 2,811; RM 1,746) via the spillway releases. During 2002, a mean daily water temperature of 18.0°C occurred on one date (June 29) on the north bank of the river at Frazer Rapids (Table 4). However, mean daily water temperature for the site on June 29 was 17.1°C when cooler water on the south bank of the river was included in the mean daily temperature calculations (Figure 5). In the absence of spillway releases, water temperature in 2001 did not reach 18°C at Frazer Rapids (Braaten and Fuller 2002). In 2000, Yerk and Baxter (2001) similarly showed that the maximum mean daily water temperature at Frazer Rapids slightly exceeded 17.0°C in mid-July.

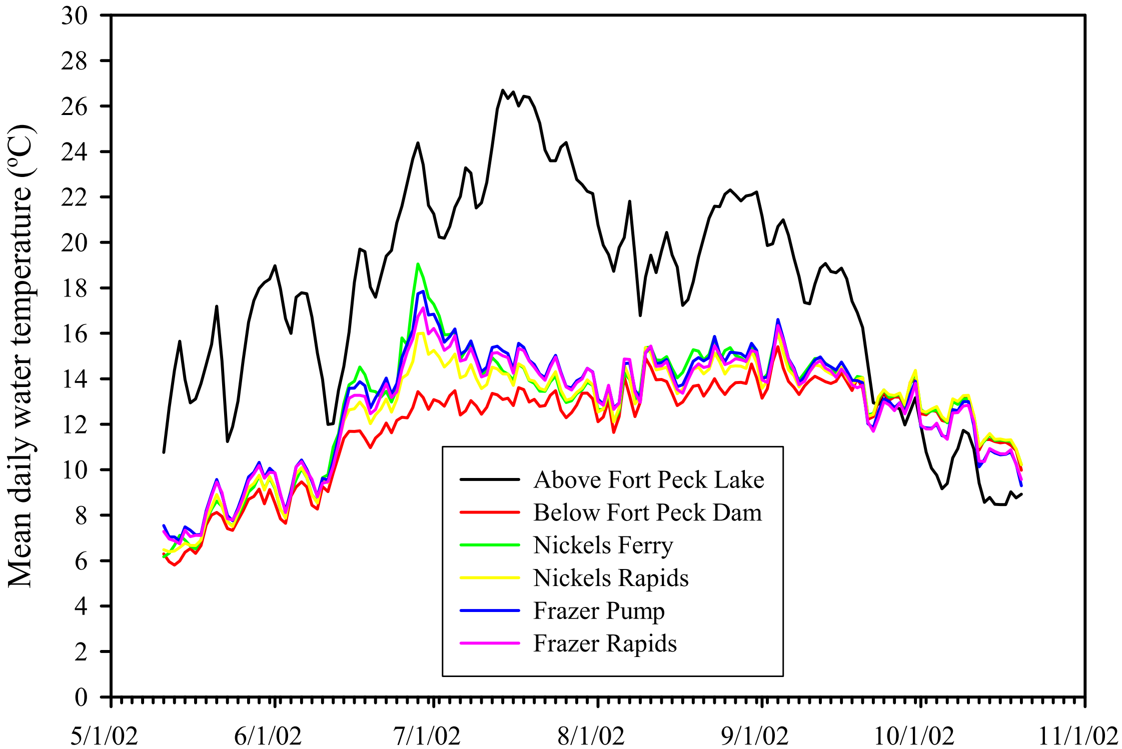
For off-channel locations, mean daily water temperature between 5/11/02-10/20/02 was highest in the Yellowstone River (18.4 °C) and Milk River (18.0 °C; Table 5). The Yellowstone River exhibited the highest variability in daily water temperatures (CV = 29.3) during the time interval.

Inter-annual comparisons of mean daily water temperature within sites. Comparisons of mean daily water temperature between 2001 and 2002 for dates spanning 5/17-10/9 indicated that 2002 was significantly cooler than 2001 at most sites (Table 6). In the free-flowing Missouri River upstream from Fort Peck Lake, water temperature averaged 1.4°C warmer in 2001. Eight of nine mainstem Missouri River sites between Fort Peck Dam and the Yellowstone River confluence averaged 0.6-1.5°C warmer in 2001 than 2002. The Nickels Ferry site (located just downstream from the Milk River confluence) was the only site between Fort Peck Dam and the Yellowstone River where water temperature was not statistically different between years (Table 6). Water temperature in the Milk River did not differ significantly between 2001. No significant differences in mean daily water temperatures were found between years in the Yellowstone River or in the Missouri River downstream from the Yellowstone River confluence (Table 6).

Mean daily air temperatures were obtained from the National Weather Service in Glasgow, MT to assess water temperature regimes during 2001 and 2002 in the context of air temperatures. For dates spanning May 1 through October 31 ($N = 184$ days), mean daily air temperature was significantly higher (t-test, $t = 2.54$, $P = 0.01$) in 2001 (mean = 16.5°C) than 2002 (mean = 14.5°C). These results corroborate findings from the water temperature analysis; however, between-year differences in air temperature (2.0°C) were slightly greater than between-differences in water temperature (0.6-1.5°C).

Table 5. Daily water temperature (°C) summary statistics (mean; minimum; maximum; standard deviation, SD; coefficient of variation, CV) for Missouri River mainstem locations and off-channel locations in 2002. Summary statistics for all sites were calculated for common deployment dates (5/11/02-10/20/02, N = 163 days) to standardize comparisons among all loggers. See Figure 5 for a graphical representation of daily water temperatures. Means with the same superscript are not significantly different ($P > 0.05$).

Location	Site	Mean	Minimum	Maximum	SD	CV
Missouri River mainstem	Robinson Bridge	17.9 [a,b]	8.5	26.7	4.7	26.5
	Below Fort Peck Dam	11.9 [g]	5.8	15.4	2.3	18.9
	Nickel Ferry	12.9 [g]	6.2	19.1	2.7	20.9
	Nickels Rapids	12.6 [g]	6.4	16.1	2.4	19.2
	Frazer Pump	12.9 [g]	6.9	17.9	2.6	19.9
	Frazer Rapids	12.8 [g]	6.7	17.1	2.5	19.5
	Grand Champs	13.1 [f,g]	7.3	17.3	2.5	19.3
	Wolf Point	14.5 [e,f]	9.0	19.4	3.1	21.3
	Culbertson	16.3 [c,d]	7.6	23.9	4.3	26.6
	Nohly	16.7 [b,c]	6.7	25.4	4.8	28.7
	Below Yellowstone River	17.9 [a,b]	6.7	27.3	5.2	28.8
Off-channel or tributary	Spillway	15.1 [d,e]	7.4	20.0	3.1	20.6
	Milk River	18.0 [a,b]	6.5	26.9	5.1	28.5
	Yellowstone River	18.4 [a]	6.9	27.9	5.4	29.3



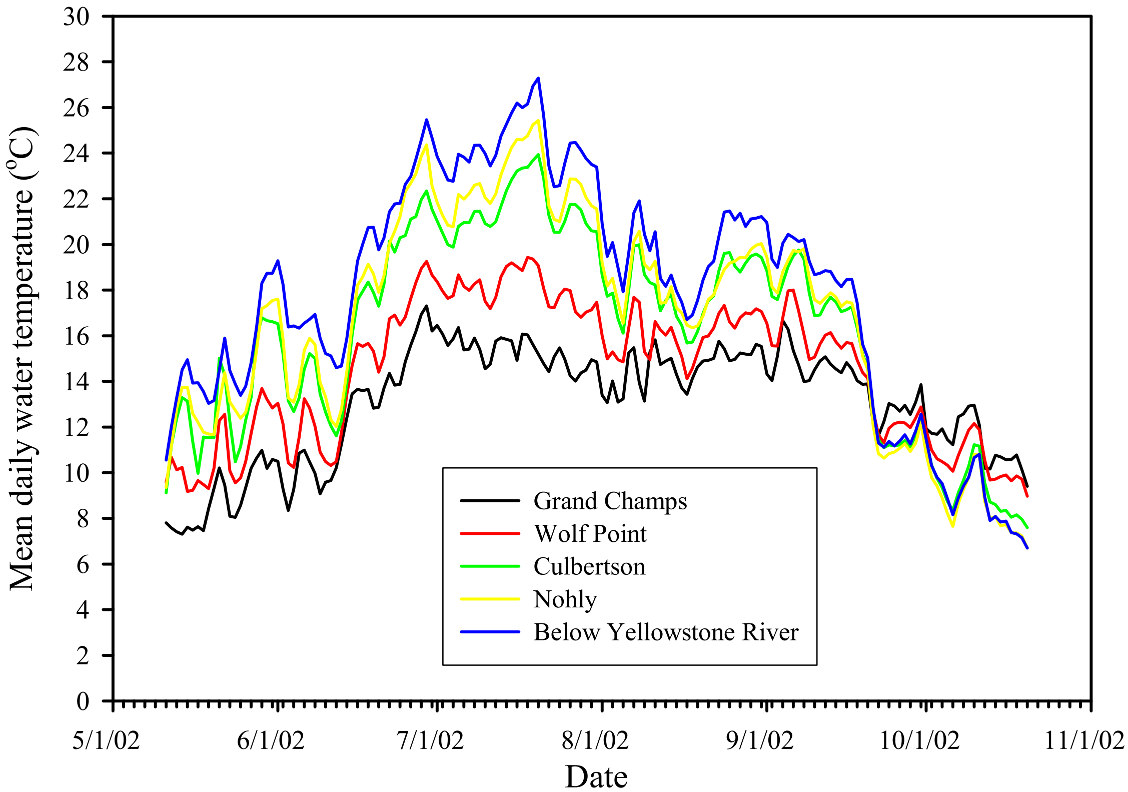


Figure 5. Mean daily water temperature (^{o}C) at 11 sites on the mainstem Missouri River during 2002.

Table 6. Summary statistics (mean, °C; standard deviation, SD; number of days, N; Probability value, P) for comparisons of mean daily water temperature between 2001 and 2002 at mainstem Missouri River sites and off-channel sites. Common dates for both years are 5/17-10/9. P-values denoted by an asterisk indicate t-test comparisons based on unequal variances.

Site	Year	Mean	SD	N	P
Missouri River above Fort Peck Lake	2001	20.1	3.7	146	0.002
	2002	18.7	4.2	146	
Below Fort Peck Dam	2001	13.0	1.5	146	< 0.0001*
	2002	12.2	2.0	146	
Spillway	2001	18.4	3.0	146	< 0.0001
	2002	15.7	2.7	146	
Milk River	2001	19.1	3.8	146	0.59*
	2002	18.9	4.5	146	
Nickels Ferry	2001	13.4	1.8	146	0.55*
	2002	13.2	2.5	146	
Nickels Rapids	2001	13.5	1.7	146	0.02*
	2002	12.9	2.2	146	
Frazer Pump	2001	13.9	1.8	146	0.03*
	2002	13.3	2.3	146	
Frazer Rapids	2001	13.8	1.84	146	0.005*
	2002	13.1	2.3	146	
Grand Champs	2001	14.4	2.0	146	0.0006
	2002	13.5	2.3	146	
Wolf Point	2001	16.5	3.1	146	< 0.0001
	2002	15.0	2.8	146	
Culbertson	2001	17.9	3.5	146	0.04
	2002	17.0	3.9	146	
Nohly	2001	18.9	3.8	146	0.005
	2002	17.5	4.3	146	
Yellowstone River	2001	19.3	4.2	146	0.96
	2002	19.3	4.8	146	
Below Yellowstone River	2001	19.4	4.1	146	0.22
	2002	18.8	4.5	146	

General comments on turbidity loggers. Two of four turbidity loggers deployed during 2002 malfunctioned during the deployment period. The turbidity logger deployed at Frazer Rapids functioned only between 5/28/02 and 6/3/02. The turbidity logger deployed near Poplar functioned only between 5/14/02 and 5/27/02. Thus, these loggers provided minimal turbidity data. However, turbidity loggers deployed in the Missouri River near Nohly (5/29/02-8/28/02) and in the Yellowstone River (5/31/02-8/31/02) functioned properly and logged hourly turbidity throughout the deployment period.

Precision of turbidity loggers. Measurements of turbidity obtained near the Nohly turbidity logger and Yellowstone turbidity logger during larval fish sampling facilitated an evaluation of turbidity logger performance during the deployment period. Mean turbidity from the turbidity loggers and larval fish sampling sites did not differ significantly at Nohly (t-test, $t = 0.30$, $P = 0.77$, $df = 36$) and in the Yellowstone River (t-test, $t = 0.43$, $P = 0.67$, $df = 34$; Table 7). Measurements of turbidity obtained from the turbidity loggers and larval fish sampling sites were highly correlated at Nohly ($r = 0.98$, $P < 0.0001$, $N = 19$) and in the Yellowstone River ($r = 0.98$, $P < 0.0001$, $N = 18$; Figure 6).

Table 7. Statistical comparisons and summary statistics (mean; standard deviation, SD.; minimum; maximum) for turbidity (NTU) measured at larval fish sampling locations (Hach meter) and by the turbidity loggers at Nohly and in the Yellowstone River. Probability values (P) are results from t-tests between instruments within sites.

Site	Instrument	N	Mean	SD	Minimum	Maximum	P
Nohly	Hach	19	325	337	72	1000	0.77
	Logger	19	294	303	14	972	
Yellowstone	Hach	18	380	338	61	1000	0.67
	Logger	18	333	311	15	1000	

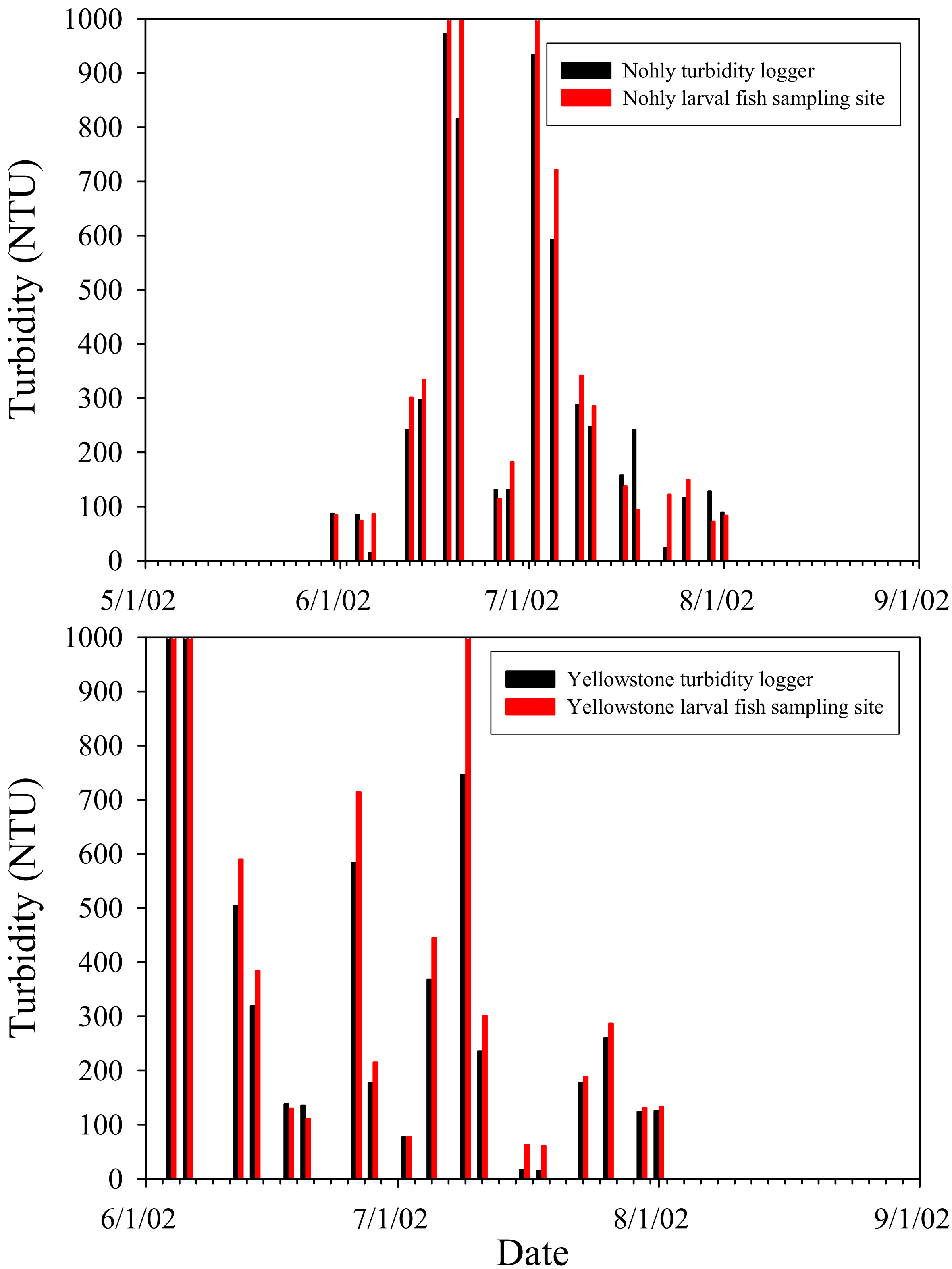


Figure 6. Mean daily turbidity (NTU) by date for Nohly (upper panel) and the Yellowstone River (lower panel).

Turbidity precision, as indexed by the range of turbidity, differed significantly ($F = 3.77$, $P = 0.04$, $df = 2, 26$) among the post-deployment turbidity levels for the Nohly and Yellowstone turbidity loggers (Table 8). Turbidity range was significantly greater ($P < 0.05$) in the high turbidity treatments (mean = 46.2 NTU) and intermediate turbidity treatments (mean = 33.2 NTU) than in the low turbidity treatments (mean = 9.2 NTU). These results indicate that turbidity range was not consistent among different turbidity levels. However, minimum turbidity and maximum turbidity differed by an average of 6% for the high turbidity treatment, 8% for the intermediate turbidity treatment, and 20% for the low turbidity treatment. Thus, although the range differed, the two turbidity loggers exhibited relatively high precision at intermediate and high turbidity levels.

Table 8. Post-deployment summary statistics for turbidity (NTU; mean, range, minimum, maximum) for the Nohly and Yellowstone River turbidity loggers in common turbidity bath samples.

Sample	Mean	Range	Minimum	Maximum
1	17.1	15.9	9.1	25.0
2	26.1	24.6	13.8	38.4
3	33.1	2.8	31.7	34.5
4	35.8	2.8	34.4	37.2
5	38.5	1.7	37.6	39.3
6	41.8	2.3	40.6	42.9
7	44.7	3.4	43.0	46.4
8	46.3	1.5	45.5	47.0
9	59.6	24.2	47.5	71.7
10	80.2	10.5	74.9	85.4
11	92.4	10.9	86.9	97.8
12	273.4	24.2	261.3	285.5
13	278.2	15.8	270.3	286.1
14	287.2	17.2	278.6	295.8
15	317.7	11.3	312.0	323.3
16	324.8	46.1	301.2	347.8
17	356.6	5.2	354.0	359.2
18	381.3	41.6	360.5	402.1
19	410.6	59.8	380.7	440.5
20	451.5	56.0	423.5	479.5
21	470.6	54.8	443.2	498.0
22	651.5	70.4	616.3	686.7
23	708.8	76.4	670.6	747.0
24	834.2	97.5	785.4	882.9
25	884.4	125.1	821.8	946.9
26	1000	0	1000	1000
27	1000	0	1000	1000
28	1000	0	1000	1000
29	1000	0	1000	1000

Field turbidity measurements. Hourly turbidity recorded by the turbidity loggers at Nohly and in the Yellowstone River varied greatly during late-May through August deployment period. At Nohly, hourly turbidity measurements exceeded 1000 NTU (maximum value of logger) on the following dates and number of times in a 24-hr period (in parenthesis): 6/17 (9), 6/18 (4), 6/19 (2), 6/26 (3), 6/30 (19), 7/1 (24), 7/2 (4), 8/21 (9), 8/23 (3), 8/24 (13), 8/25 (3), and 8/27 (7). In the Yellowstone River, turbidity exceeded 1000 NTU on the following dates and number of times in a 24-hr period (in parenthesis): 6/4 (18), 6/5 (24), 6/6 (23), 6/7 (1), 6/10 (7), 7/9 (5), 7/19 (11), 7/20 (16), and 7/21 (10). Because 1000 NTU was exceeded on specific dates, turbidity readings that exceeded 1000 NTU were truncated to 1000 NTU for estimations of mean daily turbidity. Truncation of turbidity data reduced the accuracy of mean daily estimates, resulted in conservative estimates of mean daily turbidity, and precluded quantitative statistical comparisons of spatial and temporal differences in mean daily turbidity. Nonetheless, qualitative comparisons based on conservative turbidity estimates facilitated interpretation of spatial and temporal turbidity trends. Spatially, mean daily turbidity between 5/31/02 and 8/27/02 was similar in the Missouri River at Nohly (mean = 261.6, SD = 238.3, N = 89 days) and in the Yellowstone River (mean = 255.7, SD = 244.5, N = 89 days).

Temporal patterns in mean daily turbidity varied between the Missouri River at Nohly and in the Yellowstone River. At Nohly, daily changes in turbidity generally followed increases or decreases in Missouri River discharge (Figure 7). The three periods of maximum turbidity (6/18, 7/1, 8/24) occurred 1-2 days following elevated discharges at Culberston. In the Yellowstone River, periods of elevated turbidity early in the deployment period (e.g., 6/1-7/1) generally followed periods of elevated discharge (Figure 7); however, turbidity late in the deployment period (7/1-8/31) exhibited elevated levels in the absence of significant increases in discharge.

Monitoring Component 2 – Movements by pallid sturgeon

No pallid sturgeon were found in areas immediately downstream from Fort Peck Dam. As a consequence, no pallid sturgeon were implanted with transmitters.

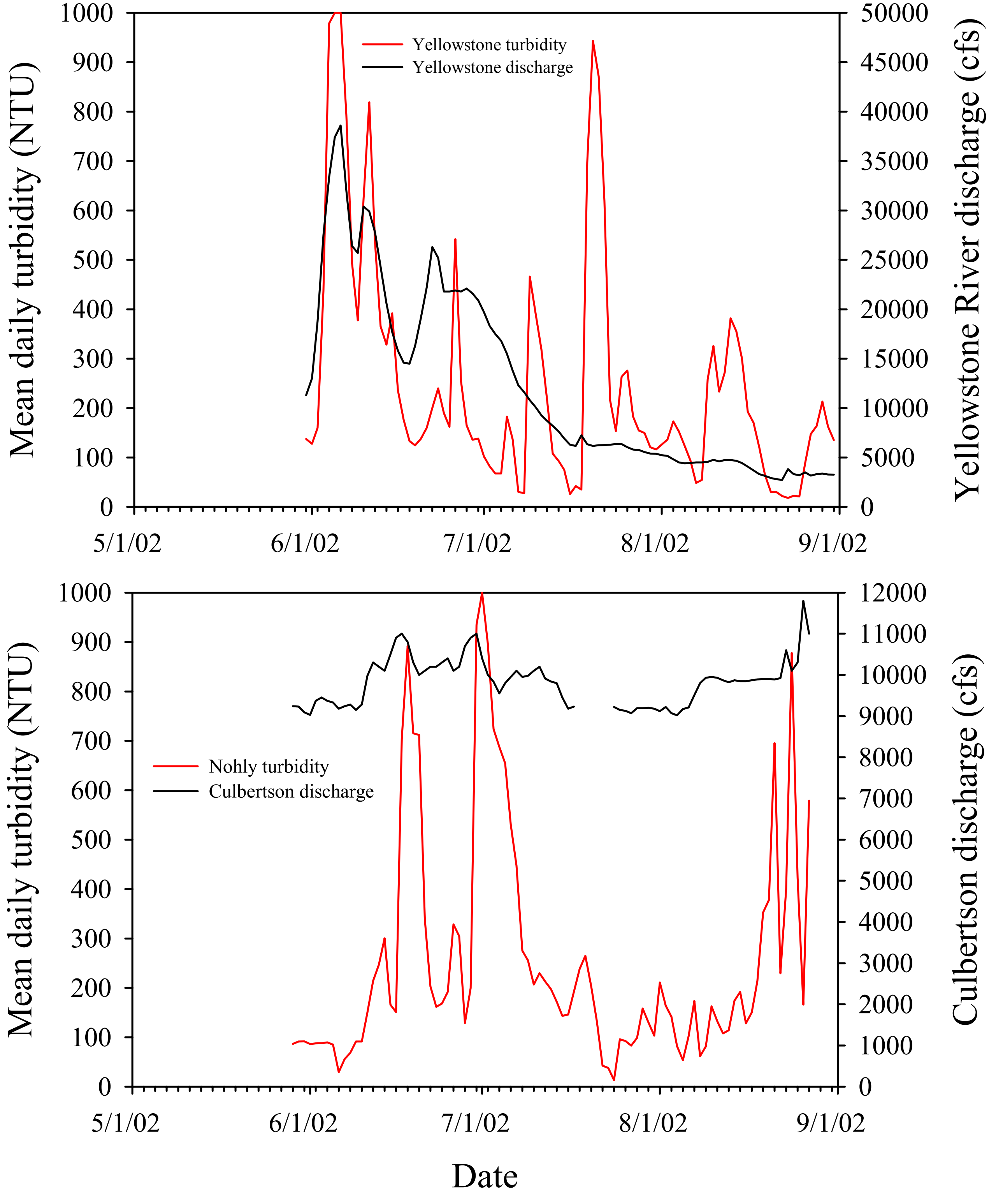


Figure 7. Mean daily turbidity (NTU; solid line) from turbidity loggers and discharge (cfs; dashed line) in the Yellowstone River (upper panel) in the Missouri River at Nohly (lower panel) during 2002.

Monitoring Component 3 – Flow- and temperature-related movements of paddlefish, blue suckers, and shovelnose sturgeon

Transmitter implantation.- Sampling throughout the study area in September 2002 resulted in the capture of 21 shovelnose sturgeon, 21 blue suckers, and 3 paddlefish suitable for transmitter implantation (Table 9). The blue suckers and shovelnose sturgeon sampled were captured throughout the study area spanning from near the Milk River to the Yellowstone River confluence. The three paddlefish captured were sampled at one location downstream from Wolf Point. Although paddlefish during fall are common in the Missouri River downstream from the Yellowstone River confluence, the Fort Peck Project was not granted permission to implant transmitters in paddlefish in this area. However, an additional 20 paddlefish (10 males, 10 females) were implanted with CART-32 transmitters in the Missouri River downstream from the confluence in fall 2002 by Dr. Dennis Scarnecchia (University if Idaho). Permission has been granted to use tracking and movement information from these individuals to augment the Fort Peck telemetry project. Individuals implanted with transmitters in 2002 will be tracked during 2003 in conjunction with fish that were implanted with transmitters in 2001.

Table 9. Number, sex ratio (male:female:undetermined), and length (mm) and weight (g) metrics for blue suckers, paddlefish, and shovelnose sturgeon implanted with transmitters during September 2002.

Species	Number	Sex ratio	Metric	Mean	Minimum	Maximum
Shovelnose sturgeon	21	2:18:1	Length	787	702	912
			Weight	2,280	1,550	3,650
Blue sucker	21	7:9:5	Length	702	637	789
			Weight	2,894	1,875	3,925
Paddlefish	3	2:0:1	Length	951	954	977
			Weight	11,833	8,900	14,050

Shovelnose sturgeon.- Of the 28 shovelnose implanted in 2001, 27 individuals were relocated in 2002. However, one individual shed the transmitter near Wolf Point in early July after swimming upstream approximately 125 kilometers. The remaining 26 fish were manually relocated five to 15 times (mean =11) throughout the season. The number of manual relocations of shovelnose sturgeon during the April to November tracking season varied from 18 to 62 among months (Table 10). Manual relocations for shovelnose sturgeon during this timeframe were augmented by 69 contacts at the logging stations (Table 10). Total movement of shovelnose sturgeon varied between 54 km and 885 km (mean = 241 km).

The number of relocations of shovelnose sturgeon varied greatly among reaches and months (Figure 8). In reach 1 (Fort Peck Dam to Wolf Point), the mean number of relocations per km was similar among months. There were five fish that resided in the reach 1 for the entire season. All these fish were implanted between Wolf Point and the Milk River. There were only three other fish that were implanted in this reach, and all eventually migrated to the Yellowstone River, one by early June, one by late June, and the other in early September. One of these fish returned to reach 1 in the fall after traveling twenty miles up the Yellowstone River. The other two remained in the Yellowstone River for the remainder of the season. Three other shovelnose sturgeon were found in this reach that had not been not implanted in reach 1. These included two fish that were implanted near Culbertson.

Table 10. Monthly totals of manual relocations and telemetry logging station contacts for shovelnose sturgeon, blue suckers, and paddlefish during 2002.

Species	Month	Manual relocations	Logging station contacts	Total contacts
Shovelnose sturgeon	April	27		27
	May	58	14	72
	June	62	15	77
	July	57	11	68
	August	19	21	40
	September	15	8	23
	October	20		20
	November	18		18
Blue sucker	April	13		13
	May	30	16	46
	June	30	17	47
	July	42	11	53
	August	11	9	20
	September	10	14	24
	October	12	5	17
	November	12		12
Paddlefish	April	27		27
	May	30	71	101
	June	42	58	100
	July	10	30	40
	August	3	34	37
	September	2	29	31
	October	10	13	23
	November	10		10

Use of reach 2 (Wolf Point to the Yellowstone River confluence) was low throughout the study period, and there was a trend of decreasing use of reach 2 from May through July (Figure 10). Nineteen shovelnose sturgeon were originally implanted in reach 2. Nine of these fish were found in the Yellowstone River on the first tracking run in April. Six additional shovelnose sturgeon were in the Yellowstone River between late April and early July. Three shovelnose sturgeon were mentioned earlier to have moved into reach 1 before migrating to the Yellowstone, and one shovelnose sturgeon shed the transmitter. Other than these early relocations, the only fish found in reach 2 were migrants passing through the reach. Bramblett and White (2001) reported the return of shovelnose that were in the Yellowstone River to this area above the confluence in the fall; however, this event did not occur in 2002. Rather, these individuals primarily stayed in the lower Yellowstone River (e.g., reach 4).

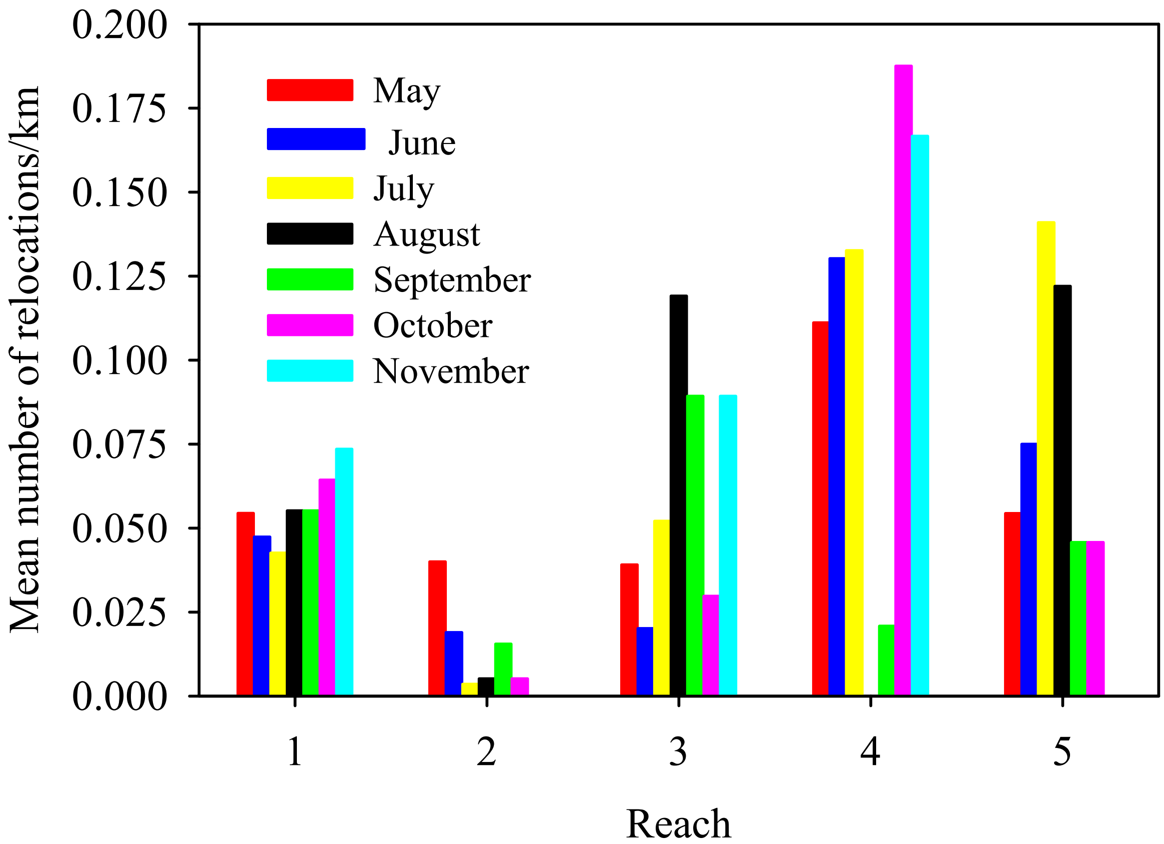


Figure 10. Mean number of shovelnose sturgeon relocations per km by month in five riverine reaches (Reach 1 = Missouri River between Fort Peck Dam and Wolf Point, Reach 2 = Missouri River between Wolf Point and the Yellowstone River confluence, Reach 3 = Missouri River from the Yellowstone River confluence to the headwaters of Lake Sakakawea, Reach 4 = Yellowstone River from the confluence to Sidney, MT, Reach 5 = Yellowstone River from Sidney, MT to Intake diversion dam).

There were relatively few relocations of shovelnose sturgeon in reach 3 (Yellowstone River confluence to Highway 85). Reach 3 is only 33.6 km; therefore, a single relocation accentuates the mean number of fish per km estimates relative to the other river reaches. The mean number of shovelnose sturgeon per km in reach 3 increased from a minimum in June to a maximum in August when four individual fish were found during one tracking run. However, three of these were found immediately below the confluence (< 1km). Only one shovelnose was found greater than 5 km downstream of the confluence.

The two reaches of the Yellowstone River generally had the highest concentration of shovelnose sturgeon; however, the mean number of shovelnose sturgeon per km varied among months within reaches. For example, the mean number of shovelnose sturgeon per km in reach 4 (Yellowstone River confluence to Sidney) minimally increased between May and July; whereas, the mean number of shovelnose sturgeon per km in reach 5 (Sidney to Intake diversion dam) greatly increased between May and July. In September, conductivities were unusually high, making the signals difficult to locate. Also of interest is the decline in the number of shovelnose sturgeon per km during August. Some of those fish moved downstream to just below the Yellowstone River confluence, and some moved above Sidney into reach 5. Although there is not an increase shown in reach 5 for August, we suspect that four individuals passed over the Intake diversion dam during the period from July to August. In addition, it is likely that one shovelnose sturgeon passed over the diversion in August. One of these fish was found later in the fall in the Yellowstone River, one was found below intake in April 2003, and three others have not been found. It should be mentioned that no tracking was conducted above Intake diversion dam to confirm passage over Intake; however, the last documented locations were at or near the diversion dam. No tracking was conducted in reach 5 during November.

Blue suckers.- Sixteen of 17 blue suckers were relocated in 2002. However, one individual shed its tag soon after being implanted, and one shed its tag near Fairview (Yellowstone River) in mid July after swimming over 300 km. The remaining 14 blue suckers were manually relocated one to 15 times (mean = 12) throughout the tracking season. A total of 160 manual relocations were obtained for blue suckers between April and November, and an additional 72 contacts were obtained from the logging stations (Table 10). Total movement of individuals varied from 5 km to 409 km (mean = 201.5 km).

Blue suckers did not exhibit large seasonal migrations as they tended to remain close to the riverine area in which they were implanted with transmitters. In reach 1, there was a slight increase in the mean number of relocations per km between June and September (Figure 9). Three fish were originally implanted with transmitters near the Milk River, and two of these fish did not leave this reach. One blue sucker was recorded on the Milk River logging station in July. The third fish went down to reach 2 for the month of July, but returned to reach 1 for the remainder of the season. One fish that was implanted near Culbertson area moved upstream to reach 1 soon after being implanted.

There was a slight decreasing trend in the number of blue suckers per km in reach 2 between May and September (Figure 9). Of the eight blue suckers implanted near Culbertson (reach 2), one individual was mentioned earlier to have moved upstream, and one was found near Williston in April and was never relocated again. We suspect this individual moved downstream into Lake Sakakawea. One blue sucker was found in reach 3 early in the year, moved to reach 2 for a month, and moved into reach 4 prior to shedding the transmitter near Fairview. The remaining five blue suckers implanted in reach 2 exhibited very little movement, and did not leave the reach.

Use of the Yellowstone River (reach 4, reach 5) by blue suckers varied among months (Figure 9). Three of the four blue suckers that were implanted at the confluence used the Yellowstone River. Use of the Yellowstone River did not appear to be related to a spawning migration because one fish moved up in April, one in May, and one in late June. Only one individual was relocated in reach 5 of the Yellowstone River, and this occurred from June through August. One blue sucker returned to reach 2 in early July while the other moved downstream to reach 3 in the fall. The other blue sucker that was implanted at the confluence spent the majority of time in reach 3 near Williston.

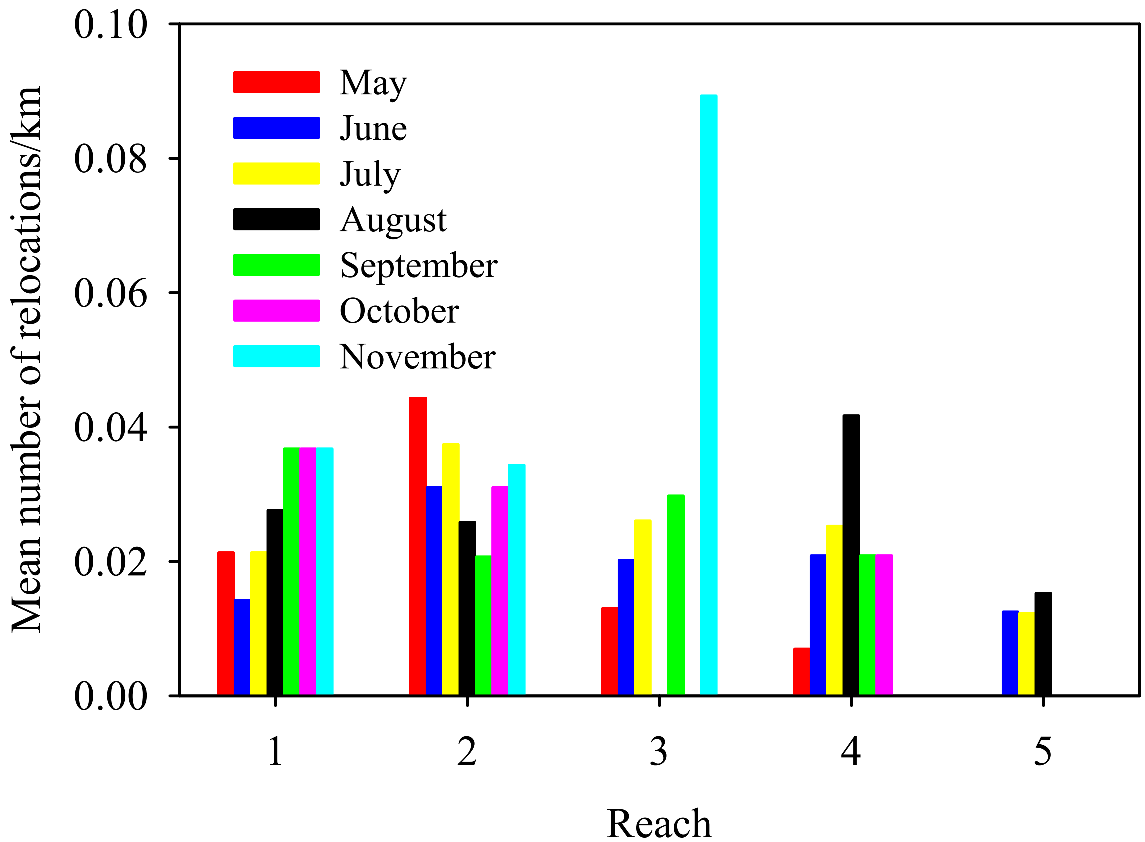


Figure 9. Mean number of blue sucker relocations per km by month in five riverine reaches (Reach 1 = Missouri River between Fort Peck Dam and Wolf Point, Reach 2 = Missouri River between Wolf Point and the Yellowstone River confluence, Reach 3 = Missouri River from the Yellowstone River confluence to the headwaters of Lake Sakakawea, Reach 4 = Yellowstone River from the confluence to Sidney, MT, Reach 5 = Yellowstone River from Sidney, MT to Intake diversion dam).

Paddlefish.-Transmitters from all nineteen paddlefish implanted in 2001 were relocated in 2002. The transmitter from one paddlefish was shed near Erickson Island soon after implantation occurred. Another paddlefish shed the transmitter in mid July near Oswego after swimming over 450 km. These 18 fish were manually relocated four to 14 times (mean = 8). Between April and November, a total of 134 manual relocations of paddlefish were obtained (Table 10). An additional 235 contacts were obtained by the telemetry logging stations. Total movement varied from 45 km to 820 km (mean = 332 km).

Paddlefish exhibited migratory patterns during the seasonal cycle (Figure 10). Ten of the eighteen paddlefish migrated up the Yellowstone River between May 16 and June 12. Four of these fish were relocated upstream from Sidney (reach 5) as determined from manual tracking and contacts at the Sidney logging station (operated by the USFWS). The maximum relocation distance upstream in the Yellowstone River was 99 km. All of these fish returned to reach 4 between June 5 and July 11. One paddlefish utilized the Missouri River and Yellowstone River, two paddlefish remained in reach 3, and the remaining five paddlefish migrated upstream the Missouri River into reaches 1 and 2. These individuals initiated migrations up the Missouri River between May 6 and June 14. Two of the five paddlefish migrated into the Milk River in mid- to late-June, and re-entered the Missouri River on July 6 and 8. Four fish returned to reach 3 between June 13 and August 16. One paddlefish shed the transmitter around July 15 near Oswego (within reach 1; Figure 1).

After the spring migrations, 11 paddlefish returned to the Erickson Island area (reach 3). These individuals were subsequently relocated several times during the fall in this area. The four paddlefish fish that used reach 1 and reach 2 of the Missouri River were not relocated in the Erickson Island area. Rather, logging stations data indicated that these individuals moved downstream below Williston.

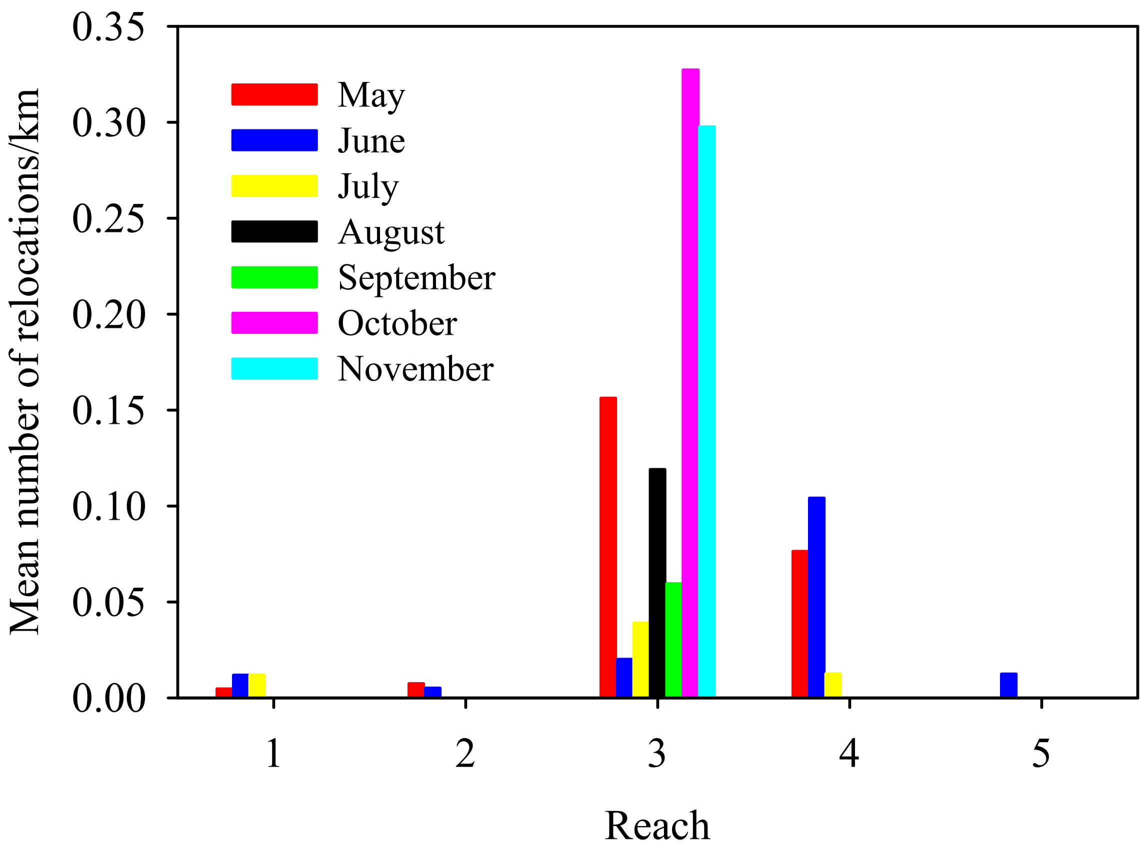


Figure 10. Mean number of paddlefish relocations per km by month in five riverine reaches (Reach 1 = Missouri River between Fort Peck Dam and Wolf Point, Reach 2 = Missouri River between Wolf Point and the Yellowstone River confluence, Reach 3 = Missouri River from the Yellowstone River confluence to the headwaters of Lake Sakakawea, Reach 4 = Yellowstone River from the confluence to Sidney, MT, Reach 5 = Yellowstone River from Sidney, MT to Intake diversion dam).

Monitoring Component 4 – Larval Fish

Larval fish were sampled on 21 individual sampling events between May 21 and August 2. However, three sites (spillway channel, Milk River, site downstream from the dam) were not sampled during one sampling event (May 31) due to equipment breakdown. The larval fish sampling regime resulted in a total of 1,965 larval fish subsamples (222 samples at the site just downstream from Fort Peck Dam, 156 samples in the spillway, 368 samples in the Milk River, 409 samples at Wolf Point, 414 samples at Nohly, 396 samples in the Yellowstone River). The volume of water sampled could not be estimated for six samples. Mean volume of water sampled per subsample was 61.9 m^3 at the site downstream from Fort Peck Dam (total = 13,740 m^3), 21.4 m^3 in the spillway (total = 3,342 m^3), 73.8 m^3 in the Milk River (total = 27,164 m^3), 74.3 m^3 at Wolf Point (total = 30,406 m^3), 63.5 m^3 at Nohly (total = 26,034 m^3), and 45.4 m^3 in the Yellowstone River (total = 17,887 m^3).

Relative abundance of larval fishes and eggs. A total of 41,768 larvae representing ten families were sampled from all sites during 2002, and nearly 77% of the larvae were sampled in the Milk River (Table 11). Catostomidae (suckers) and Cyprinidae (minnows and carps) were sampled at all sites. Two families (Hiodontidae, exclusively goldeye; Percidae, perches) were sampled at all sites except the site downstream from Fort Peck Dam. Polyodontidae (exclusively paddlefish) were sampled in the Milk River, Yellowstone River, and in the Missouri River

Table 11. Number (N) and frequency (%) of larval fishes, and numbers of juveniles, adults, and eggs sampled at six sites during 2002. T = less than 0.1%.

	Below Fort Peck Dam		Spillway		Milk River		Wolf Point		Nohly		Yellowstone River	
Taxon	N	%	N	%	N	%	N	%	N	%	N	%
Acipenseridae							5	T			9	0.7
Catostomidae	158	93.5	291	87.9	25,601	79.9	5915	87.8	476	43.1	605	44.0
Centrarchidae									2	0.2		
Cyprinidae	4	2.4	12	3.6	4,447	13.9	363	5.4	118	10.7	469	34.1
Hiodontidae			3	0.9	818	2.6	67	1.0	101	9.1	175	12.7
Ictaluridae					8	T					3	0.2
Percidae			2	0.6	1	T	240	3.6	326	29.5	22	1.6
Polyodontidae					7	T	27	0.4	14	1.3	34	2.5
Salmonidae	3	1.8					14	0.2	35	3.2		
Sciaenidae			4	1.2	1,142	3.6	93	1.4	23	2.1		
Unknown	4	2.4	19	5.7	27	T	13	0.2	9	0.8	59	4.3
Total larvae	169		331		32,051		6,737		1,104		1,376	
Juveniles			3		413				12		5	
Adults	4		9		347		2		2		1	
Sturgeon/ paddlefish eggs							1					4
Unknown eggs	333		33		4,461		2,425		1,965			5,838

at Wolf Point and Nohly. Sciaenidae (exclusively freshwater drum) were identified from four sites (spillway, Milk River, Wolf Point, Nohly). Salmonidae were sampled at Wolf Point, Nohly, and at the site downstream from Fort Peck Dam. Families minimally represented in the samples included Ictaluridae (catfishes) that were sampled only in the Milk River and Yellowstone River, and Acipenseridae (sturgeons) that were found only at Wolf Point and in the Yellowstone River. Centrarchidae (sunfishes) were sampled only at Nohly. Excluding larvae that could not be definitively identified, the greatest number of families occurred in the Missouri River at Wolf Point (8 families) and Nohly (8 families). Seven families were identified from samples in the Milk River and Yellowstone River. The least number of families occurred in the spillway (5 families) and at the site downstream from Fort Peck Dam (3).

Composition of the larval fishes sampled in 2002 varied among taxa and sites (Table 10). Nearly 98% of larval fishes sampled were represented by Catostomidae (79.1%), Cyprinidae (13.0%), Sciaenidae (3.0%), and Hiodontidae (2.8%). Whereas Catostomidae was the dominant taxon sampled, the proportion of catostomids varied among sites. Catostomids comprised greater than 79% of the fish community at the site downstream from Fort Peck Dam, in the spillway channel, in the Milk River, and at Wolf Point, but the proportion of the community comprised of catostomids decreased to 43% at Nohly and 44% in the Yellowstone River. The majority of larval cyprinids (primarily common carp *Cyprinus carpio*) were sampled in the Milk River (82.2%) and at Wolf Point (6.7%). Similarly, of the 1,262 larval freshwater drum sampled, 90.5% were sampled in the Milk River and 7.4% at Wolf Point. The majority of larval goldeye (70.3%) were sampled in the Milk River, but goldeye were also common in the Yellowstone River (15.0%) and at Nohly (8.7%). The majority of larval percids (primarily *Stizostedion* sp.) were sampled at Nohly (55.2%) and Wolf Point (40.6%). Of the 82 larval paddlefish sampled, 41.5% were sampled in the Yellowstone River, 32.9% at Wolf Point, 17.1% at Nohly, and 8.5% in the Milk River. The 14 larval sturgeon sampled in 2002 were distributed between Wolf Point (35.7%) and the Yellowstone River (64.3%).

Spatial and temporal periodicity and densities of Acipenseridae and Polyodontidae larvae. Larval sturgeon were not sampled in the Milk River during 2002, but seven larval paddlefish were collected (Table 12). Collections of larval paddlefish in the drift occurred on June 25 and July 8, and mean densities were less than 0.50 larvae/100 m^3 (Table 12). No larval sturgeon were sampled from the Milk River in 2001, and only one paddlefish larvae was sampled from the Milk River in 2001 (July 2; Braaten and Fuller 2002).

Table 12. Number sampled, mean density (mean; number/100 m^3), median density (median), minimum density (min.), and maximum density (max.) of paddlefish larvae sampled by date in the Milk River.

	Date 2002																			
	May		June								July									Aug
Metric	21	28	3	6	10	13	17	20	25	28	1	3	8	12	15	19	22	26	29	2
Number sampled									2				5							
Mean									0.50				0.29							
Median									0				0.31							
Min									0				0							
Max									1.35				0.57							

Samples of larval fishes at Wolf Point included sturgeon and paddlefish (Table 13). First collections of larval sturgeon at Wolf Point occurred on July 15 (mean density = 0.06 larvae/100 m^3). Larval sturgeon were also sampled on July 18 and August 2, but mean density was low (< 0.20 sturgeon/100 m^3). Collections of larval paddlefish (27 total) were distributed between early and late sampling dates. Mean density varied from 0.13 larvae/100 m^3 to 0.46 larvae/100 m^3 during June 24-July 5, and from 0.20 larvae/100 m^3 to 0.35 larvae/100 m^3 during July 15-July 25. Braaten and Fuller (2002) found six larval sturgeon at Wolf Point in 2001, and these were sampled on July 17 (1), July 19 (2), and July 24 (3). A total of eight larval paddlefish were sampled in 2001, and these were collected on June 19 (2), June 22 (1), June 26 (2), June 28 (2), and July 11 (1).

Table 13. Number sampled, mean density (mean; number/100 m^3), median density (median), minimum density (min.), and maximum density (max.) of larval sturgeon (*Scaphirhynchus* sp.) and larval paddlefish sampled by date in the Missouri River at Wolf Point.

	Date 2002																				
	May			June								July									Aug
Metric	21	28	31	3	7	10	14	18	21	24	27	1	5	8	11	15	18	22	25	29	2
	Scaphirhynchus sp.																				
Number sampled																1	1				3
Mean																0.06	0.07				0.19
Median																0	0				0
Min																0	0				0
Max																0.32	0.35				0.60
	Paddlefish																				
Number sampled										2	6	6	2			4	3		4		
Mean										0.13	0.43	0.46	0.17			0.27	0.20		0.35		
Median										0	0.31	0.37	0			0.28	0		0		
Min										0	0	0	0			0	0		0		
Max										0.35	1.44	1.11	0.83			0.71	1.02		1.39		

Larval sturgeon were not sampled in the Missouri River at Nohly during 2002, but 14 paddlefish larval were sampled between July 2 and July 16 (Table 14). Mean density varied from 0.14 larvae/100 m^3 to 0.35 larvae/100 m^3. During 2001, Braaten and Fuller (2002) sampled ten larval sturgeon at Nohly on June 21 (1), June 28 (1), July 10 (2), July 13 (2), July 18 (1), July 24 (1), and July 25 (2). Only four larval paddlefish wee sampled in 2001 and these were collected on June 28 (3) and July 25 (1).

Table 14. Total number (number), mean density (mean; number/100 m^3), median density (median), minimum density (min.), and maximum density (max.) of paddlefish larvae sampled by date in the Missouri River at Nohly.

	Date 2002																				
	May			June								July									Aug
Metric	22	29	31	4	6	12	14	18	20	26	28	2	5	9	11	16	18	23	26	30	1
	Paddlefish																				
Number sampled												4	4	2	2	2					
Mean												0.35	0.34	0.19	0.14	0.14					
Median												0.38	0	0	0	0					
Min												0	0	0	0	0					
Max												0.99	0.90	0.93	0.69	0.68					

Larval fish samples from the Yellowstone River yielded a total of 9 larval sturgeon and 34 larval paddlefish (Table 15). Sturgeon larvae were sampled on three dates (June 28, July 5, July 9), and mean density varied from 0.09 larvae/100 m^3 to 0.64 larvae/100 m^3. Larval paddlefish were sampled nearly continuously from their first occurrence in the drift on June 6 to the last occurrence in the drift on July 5. Mean densities of larval paddlefish varied from 0.19 larvae/100 m^3 (June 28) to 1.48 larvae/100 m^3 (June 20). A total of eight larval sturgeon were sampled in the Yellowstone River during 2002 (Braaten and Fuller 2002), and these were found on June 25 (2), June 28 (1), July 3 (1), July 6 (2), July 17 (1), and July 25 (1). Twenty-three paddlefish were sampled from the Yellowstone River during 2001 (Braaten and Fuller 2002). Individuals during 2001 were sampled on May 29 (4), May 31 (2), June 12 (2), June 15 (2), June 18 (1), June 21 (1), June 25 (10), and July 25 (1).

Table 15. Total number (number), mean density (mean; number/100 m^3), median density (median), minimum density (min.), and maximum density (max.) of larval sturgeon (*Scaphirhynchus* sp.) and larval paddlefish sampled by date in the Yellowstone River.

	Date 2002																				
	May			June								July									Aug
Metric	22	29	31	4	6	12	14	18	20	26	28	2	5	9	11	16	18	23	26	30	1
	Scaphirhynchus sp.																				
Number sampled											2		6	1							
Mean											0.14		0.64	0.09							
Median											0		0.66	0							
Min											0		0	0							
Max											0.40		1.37	0.47							
	Paddlefish																				
Number sampled					1	3	3	5	11	3	3		5								
Mean					0.25	0.55	0.33	0.79	1.48	0.41	0.19		0.46								
Median					0	0	0	0.70	1.59	0.54	0.30		0								
Min					0	0	0	0	0.60	0	0		0								
Max					1.24	2.77	1.63	2.21	1.92	0.80	0.34		1.82								

Larval nets fished on the bottom tended to sample a greater number of larval sturgeon and larval paddlefish than nets fished in the mid-water column. Of the 14 larval sturgeon sampled during 2002, 9 larvae (64.3%) were sampled in larval nets fished on the bottom. Excluding Milk River samples that were fished exclusively on the surface, 47 larval paddlefish (62.7%) were sampled in larval nets fished on the bottom. In addition to larvae, five sturgeon/paddlefish eggs were sampled during 2002; these were collected at Wolf Point (July 18, N = 1) and in the Yellowstone River (June 12, N = 1; June 18, N = 1; June 26, N = 1; July 2, N = 1). Braaten and Fuller (2002) reported that 70.8% of the larval sturgeon sampled in 2001 were collected in bottom samples. About 62% of the larval paddlefish sampled in 2001 were obtained from bottom samples.

Spatial and temporal periodicity and densities of larval fishes exclusive of Acipenseridae and Polyodontidae. Mean density of larval fishes at the site downstream from Fort Peck Dam varied between 0 and 4.7 larvae/100 m^3 among sampling periods (Figure 11). Maximum densities of larvae occurred on July 3 (mean = 4.27 larvae/100 m^3) and July 12 (mean = 4.7 larvae/100 m^3) when catostomids averaged greater than 94% of the larvae densities. Salmonids comprised 100% of the larval fish densities on May 21 (mean 1.07 larvae/100 m^3) and June 6 (mean = 0.12 larvae/100 m^3). Cyprinids (exclusively common carp) were sampled on two dates (July 15, July 22), but at low densities (mean ≤ 0.44 larvae/100 m^3).

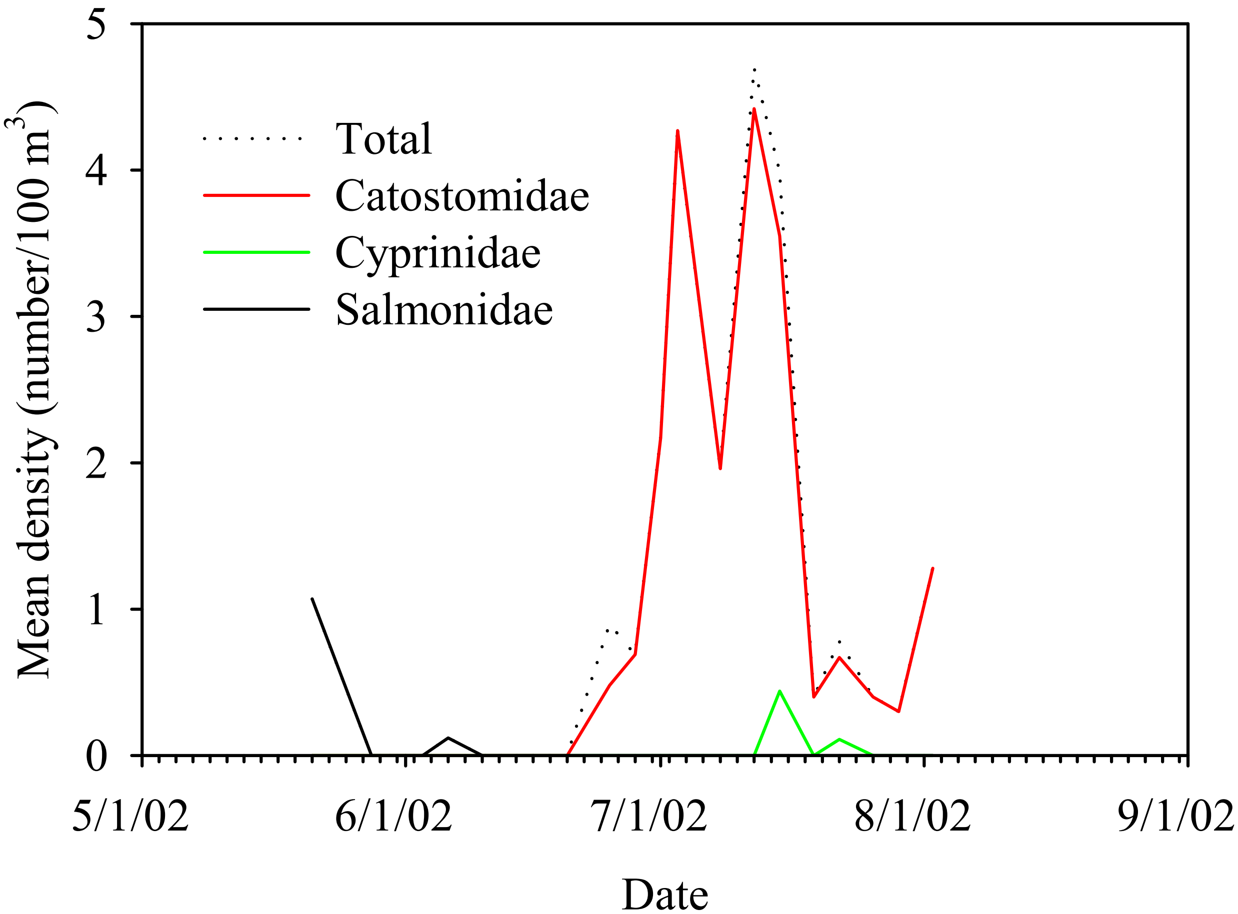


Figure 11. Mean density (number/100 m^3) by date of all larval fishes (Total), Catostomidae, Cyprinidae, and Salmonidae sampled in the Missouri River at the site downstream from Fort Peck Dam during 2002.

In the spillway channel, mean density of larval fishes varied from 0 larvae/100 m^3 to 74 larvae/100 m^3 (Figure 12). Mean density was low through late June (< 18 larvae/100 m^3), peaked on July 1 as catostomids comprised great than 98% of the larval fishes sampled, then declined through the beginning of August. Mean density of larval Cyprinidae, Hiodontidae, Percidae , and Sciaenidae were low (≤ 4.0 larvae/100 m^3) throughout the sampling period.

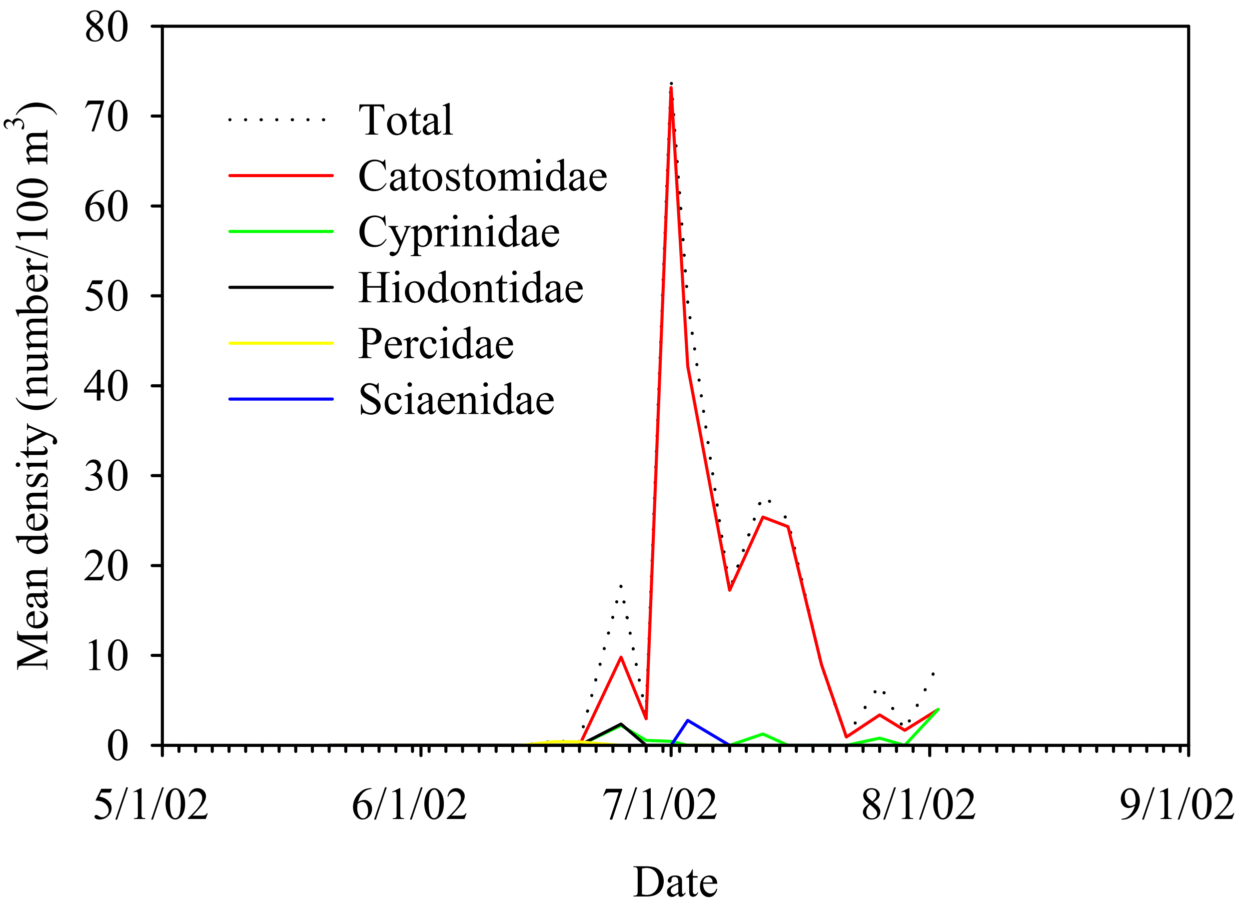


Figure 12. Mean density (number/100 m^3) by date of all larval fishes (Total), Catostomidae, Cyprinidae, Hiodontidae, Percidae, and Sciaenidae sampled in the Fort Peck spillway channel during 2002.

Composition and densities of larval fishes in the Milk River exhibited pronounced temporal variations (Figure 13). Densities of all taxa were low (< 27 larvae/100 m^3) through June 20. Mean density increased substantially to 3,673 larvae/100 m^3 on June 25 when catostomids (mean density = 3,205 larvae/100 m^3) comprised 87% of the larvae, cyprinids (mean density = 348 larvae/100 m^3) comprised 9.5% of the larvae, and hiodontidae (mean density = 105/100 m^3) comprised 2.9% of the larvae. Density of larval freshwater drum (Sciaenidae) peaked on June 28 (mean = 57.8 larvae/100 m^3) as densities of other taxa declined through late July. Whereas common carp larvae comprised 95-100% of the cyprinids sampled from June 13 to July 12, larval cyprinids exclusive of common carp comprised 100% of the cyprinid larvae from the July 19 through August 2 sampling periods.

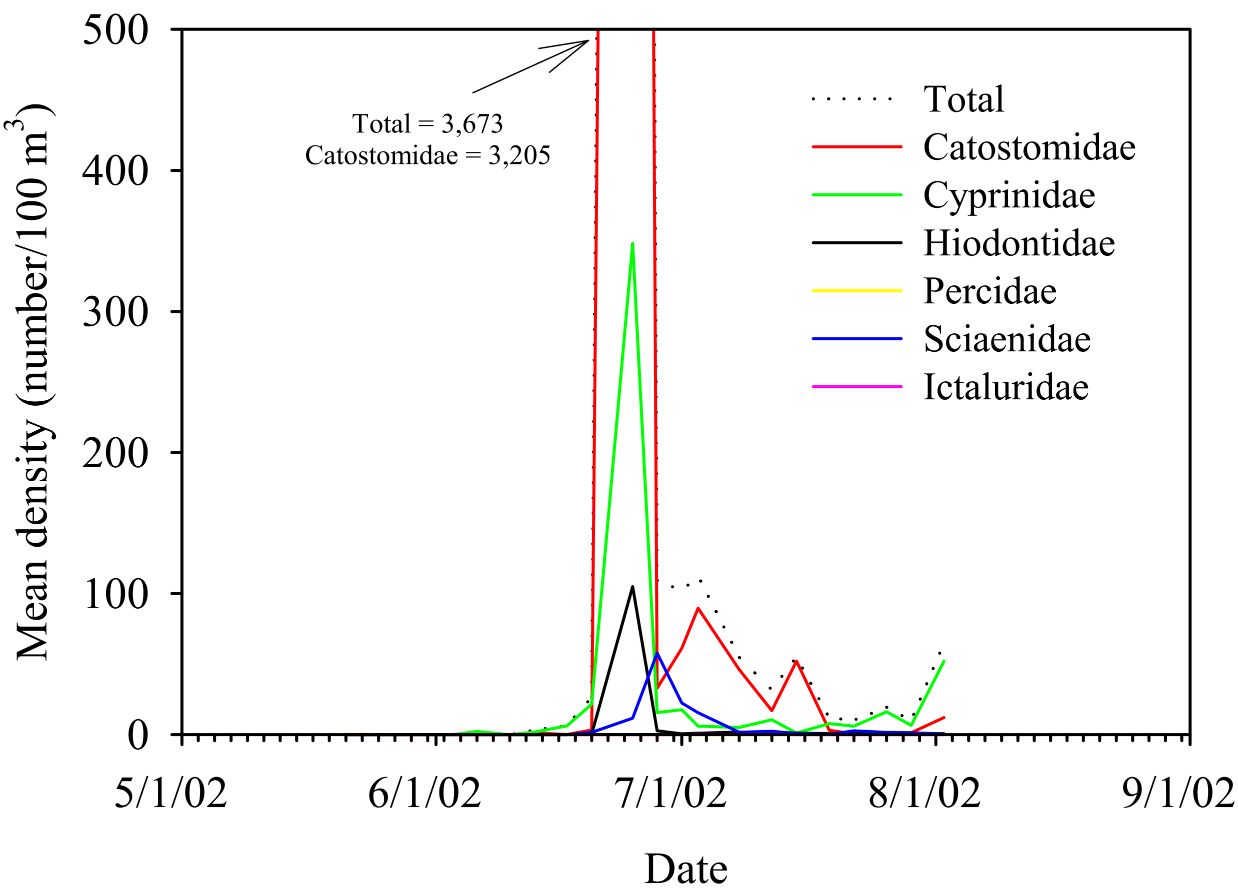


Figure 13. Mean density (number/100 m^3) by date of all larval fishes (Total), Catostomidae, Cyprinidae, Hiodontidae, Percidae, Sciaenidae, and Ictaluridae sampled in the Milk River during 2002.

Larval fishes sampled at Wolf Point exhibited temporal variations in taxon composition and density among sampling periods (Figure 14). Between May 28 and June 18, larval densities were low (< 4.4 larvae/100 m^3) and were dominated by larval percids (primarily *Stizostedion* sp.). Mean density increased to a maximum of 338.4 larvae/100 m^3 on June 27 primarily as a result of an increase in density of catostomids (mean density = 316 larvae/100 m^3) and cyprinids (mean density = 18.1 larvae/100 m^3). Hiodontidae also exhibited maximum density on June 27 (mean density = 3.45 larvae/100 m^3). Mean density of catostomidae and cyprinidae decreased after June 27; whereas, density of Sciaenidae increased on July 1 (mean = 2.13 larvae/100 m^3) and July 5 (mean = 2.38 larvae/100 m^3). Between June 14 and July 1, common carp comprised 67-100% of the larval cyprinids sampled at Wolf Point.

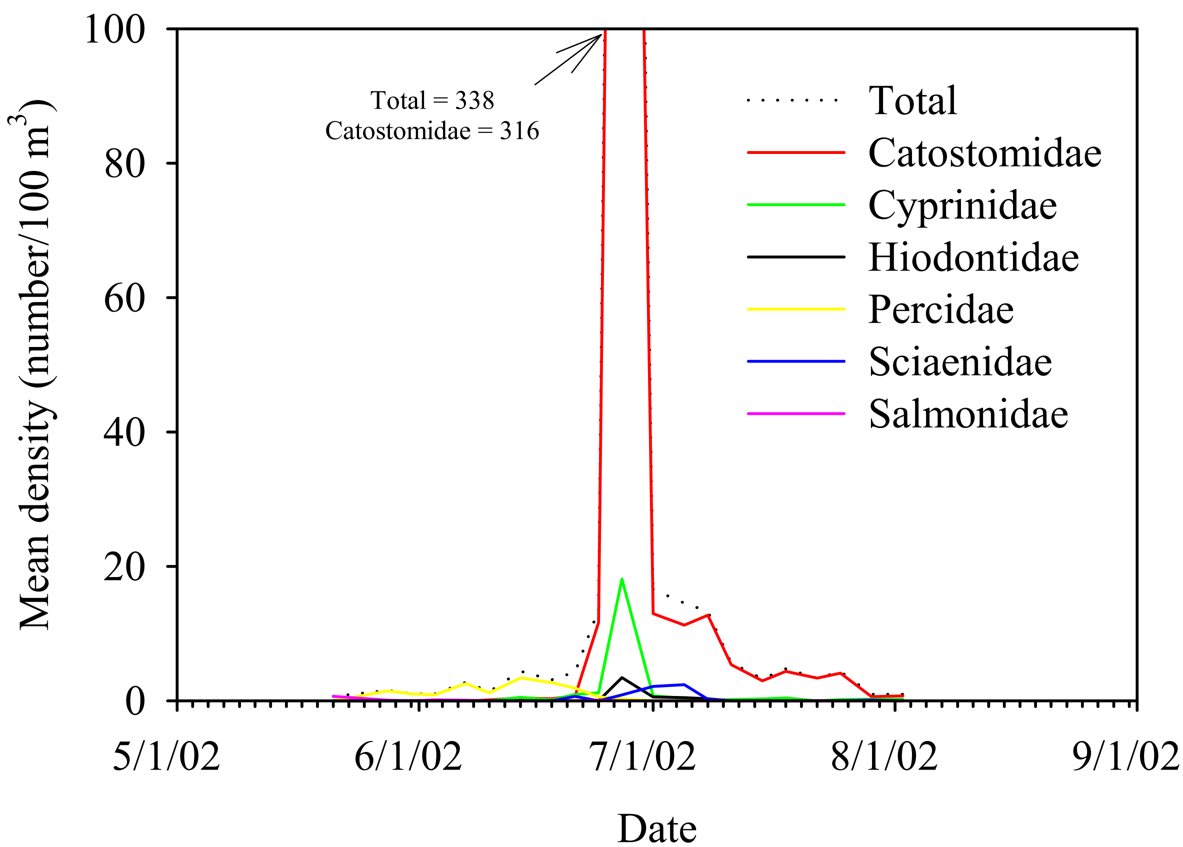


Figure 14. Mean density (number/100 m^3) by date of all larval fishes (Total), Catostomidae, Cyprinidae, Hiodontidae, Percidae, Sciaenidae, and Salmonidae sampled in the Missouri River at Wolf Point during 2002.

Mean total density of larval fishes sampled at Nohly varied from 0.30 larvae/100 m^3 to 16.6 larvae/100 m^3 throughout the sampling period (Figure 15). Larval percids (primarily *Stizostedion* sp.) were the dominant taxon sampled between May 29 and June 20 (mean densities 1.31-5.8 larvae/100 m^3). Total density of larvae increased on June 28 as catostomids exhibited maximum density (mean = 9.44 larvae/100 m^3). Total density continued to increase through July 2 with contributions from catostomids (mean = 7.83 larvae/100 m^3), hiodontidae (mean = 5.0 larvae/100 m^3), cyprinidae (2.2 larvae/100 m^3), and sciaenids (1.2 larvae/100 m^3). Common carp comprised 40-100% of the cyprinidae sampled between June 12 and July 11. Total density declined after early July, and the larval community was composed exclusively of catostomids and cyprinid (non-common carp) larvae.

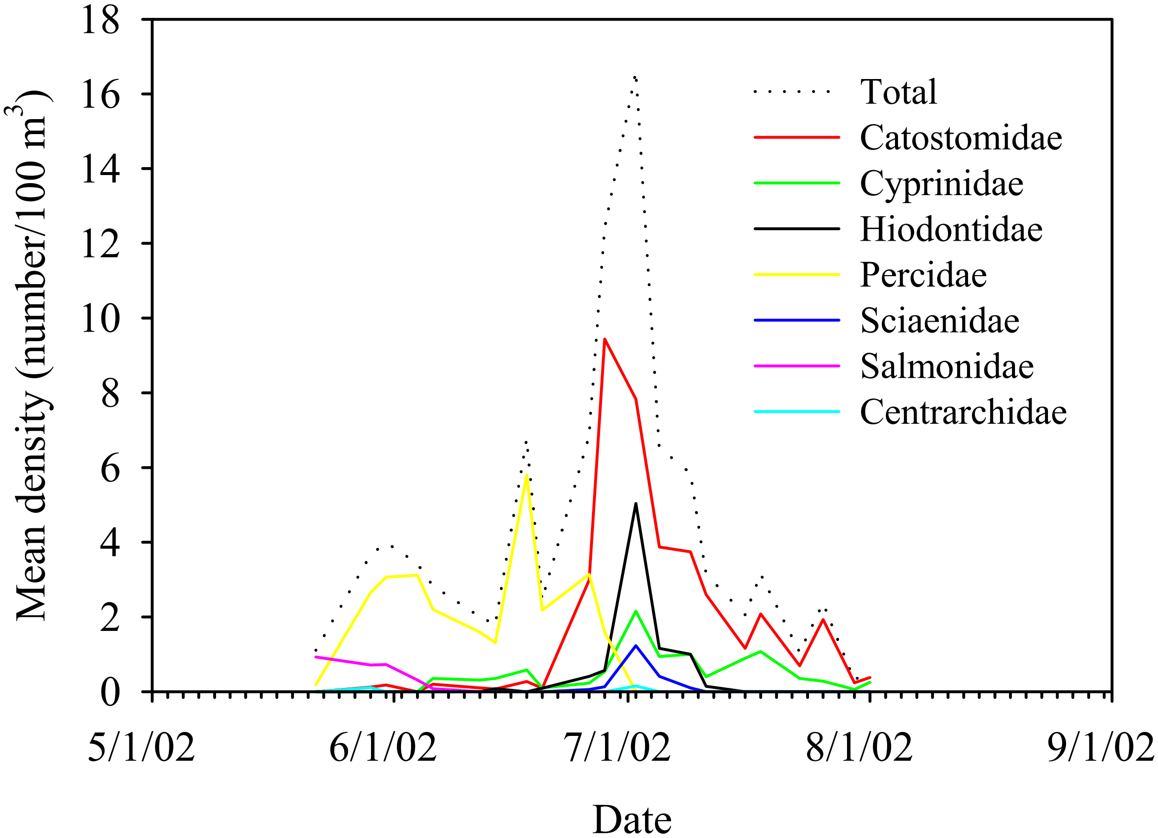


Figure 15. Mean density (number/100 m^3) by date of all larval fishes (Total), Catostomidae, Cyprinidae, Hiodontidae, Percidae, Sciaenidae, Salmonidae, and Centrarchidae sampled in the Missouri River near Nohly during 2002.

Mean total density of larval fishes in the Yellowstone River varied between 0.3 larvae/100 m^3 and 45.9 larvae/100 m^3 during the late-May through early August sampling periods (Figure 16). Larval fish samples from late May through late June were composed predominately of larval goldeyes (mean density 0.3 - 5.7 larvae/100 m^3) and to a lesser extent catostomids (mean density = 0 – 2.5 larvae/100 m^3) and cyprinids (mean density = 0 – 2.9 larvae/100 m^3). Larval common carp comprised 62-100% of the cyprinid larvae sampled from late May through late June. The initial peak in total density peaked occurred on July 9 when catostomids comprised 94% of the larval fish density. The second period of high larval densities occurred on July 16 and July 18 as cyprinds (non-common carp) comprised 86-93% of the larval fish densities.

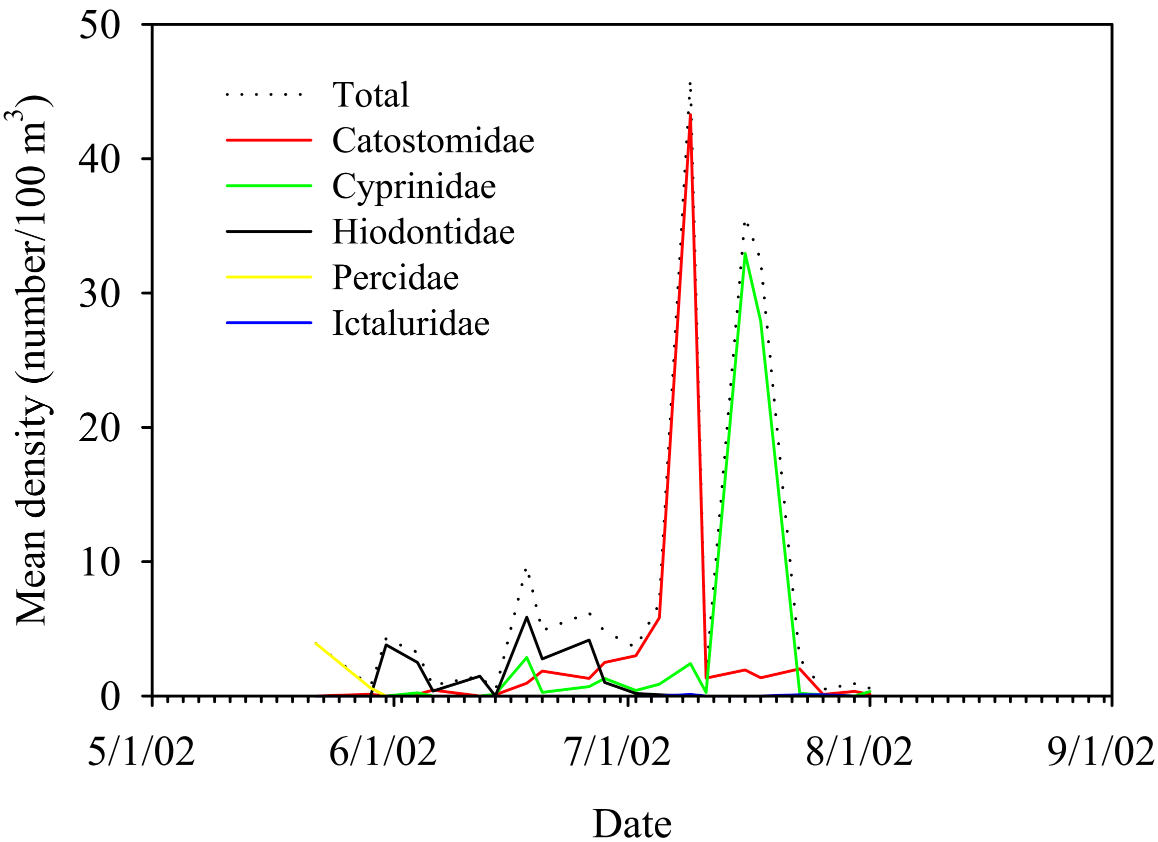


Figure 16. Mean density (number/100 m^3) by date of all larval fishes (Total), Catostomidae, Cyprinidae, Hiodontidae, Percidae, and Ictaluridae sampled in the Yellowstone River during 2002.

Inter-annual trends in larval fish densities.-A complete analysis of spatial and temporal changes in larval fish densities resulting from the Fort Peck spillway releases will be conducted after completion of the project. However, summary statistics from the 2001 and 2002 larval fish data sets were computed to illustrate inter-annual trends. Pooled across late-May through late July sampling dates (common dates for both years), larval fish densities (all taxa) were generally greater during 2002 than 2001 in the Milk River and in the Missouri River at Wolf Point (Figure 17). Mean densities were generally similar between years at the site downstream from the dam (2001 mean = 1.06 larvae/100 m^3; 2002 mean = 1.26 larvae/100 m^3), in the spillway channel (2001 mean = 19.79 larvae/100 m^3; 2002 mean = 13.66 larvae/100 m^3), at Nohly (2001 mean = 5.89 larvae/100 m^3; 2002 mean = 4.91 larvae/100 m^3), and in the Yellowstone River (2001 mean = 3.58 larvae/100 m^3; 2002 mean = 9.55 larvae/100 m^3). Elevated discharge in the Milk River during 2002 may have enhanced spawning success, and there is evidence to suggest that the increased density of larval fishes at Wolf Point was influenced by the higher densities originating from the Milk River during 2002. For example, peak densities at Wolf Point in 2002 occurred on June 27 (Figure 14), two days after peak densities were observed in the Milk River (Figure 13). Milk River discharge increased substantially during this time period (Figure 2) and likely transported larval fish downstream to Wolf Point. The benefit of enhanced larval production in

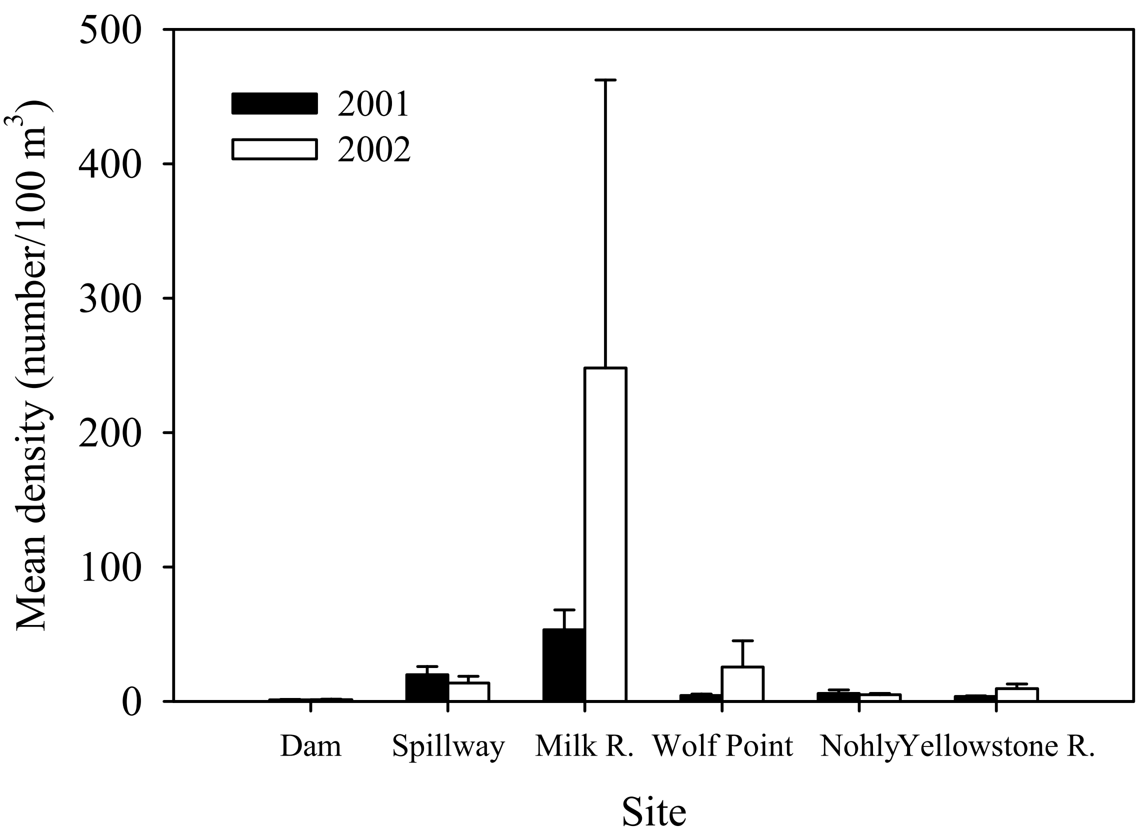


Figure 17. Mean total density (number/100 m^3; lines denote 1 standard error) of larval fishes sampled at six sites in 2001 and 2002.

the Milk River was not evident at the Nohly site suggesting that the larval fish either settled to benthic habitats upstream from Nohly or experienced high mortality levels during the drift-transport process to Nohly.

Monitoring Component 5 – Food habits of piscivorous fishes

Four burbot were sampled during July and August 2002. Individuals varied from 237 mm to 306 mm (mean = 286 mm), and from 50 g to 175 g (mean = 129 mm). The four stomachs were empty; thus, no information on food habits was obtained.

Stomachs from 62 channel catfish (mean length = 387 mm, 212 - 630 mm; mean weight = 610 g, 50 - 2,525 g) were obtained during July and August 2002. Five stomachs (8.1%) were empty. A variety of prey organisms was found in the stomach contents of channel catfish, but orthopterans (e.g., grasshoppers) represented the highest frequency of occurrence (43.9% of the stomachs) and frequency by number (66.2%) of food items ingested (Table 14). Fish (Class Osteichthyes) were found in 31.6% of the channel catfish, and identifiable fish in the diet included goldeyes and ictalurids (i.e., catfishes). Five diet components (miscellaneous material, orthopterans, unknown fish, goldeye, and mammals) comprised 81.7% of the diet weight.

Table 14. Frequency of occurrence (%, number of individuals containing the specific food item/ number of stomachs containing food), numerical frequency (%, total number of taxon-specific food items/total number of all food items), and weight frequency (%, total weight of a taxon-specific food item/total weight of all food items) of diet components for channel catfish sampled in the Missouri River during July and August 2002. T = less than 0.1%.

Diet component		Frequency of occurrence (%)	Frequency by number (%)	Frequency by weight (%)
Insecta	Coleoptera	19.3	7.4	0.3
	Ephemeroptera	3.5	0.6	T
	Hemiptera	3.5	1.3	T
	Lepidoptera	3.5	1.0	0.7
	Odonata	1.8	0.3	T
	Orthoptera	43.9	66.2	17.0
	Trichoptera	17.5	5.5	0.1
	Unknown	14.0	7.4	0.3
Crustacea	Decapoda	5.3	1.0	1.2
Gordoida	Nematomorpha	5.5	1.6	T
Mammalia		1.8	0.3	14.2
Osteichthyes		31.6		
	Goldeye	1.8	0.3	15.6
	Ictaluridae	3.5	0.6	6.7
	Unknown	26.3	4.8	16.1
Aves		3.5	0.6	1.0
Arachnida	Araneae	1.8	0.3	T
Fungi		1.8	0.3	3.7
Unknown		1.8	0.3	T
Detritus		28.1		4.1
Miscellaneous		42.1		18.8
			Total organisms = 311	Total weight = 423.99 g

Eight freshwater drum (mean length = 385 mm, 317 – 469 mm; mean weight = 797 g, 400 – 1,300 g) were sampled in July and August 2002, and all eight stomachs contained food items (Table 15). Fish represented the highest frequency of occurrence (75% of the stomachs), but insects and crustaceans were also present in the diet. Ephemeropterans (e.g., mayflies) represented the highest frequency by number (34.8%); whereas, decapods (e.g., crayfish) dominated the diet on a weight basis (88.3%).

Table 15. Frequency of occurrence (%, number of individuals containing the specific food item/ number of stomachs containing food), numerical frequency (%, total number of taxon-specific food items/total number of all food items), and weight frequency (%, total weight of a taxon-specific food item/total weight of all food items) of diet components for freshwater drum sampled in the Missouri River during July and August 2002. T = less than 0.1%.

Diet component		Frequency of occurrence (%)	Frequency by number (%)	Frequency by weight (%)
Insecta	Diptera	12.5	4.3	T
	Ephemeroptera	12.5	34.8	0.7
	Unknown	37.5	34.8	1.1
Crustacea	Decapoda	37.5	13.0	88.3
Osteichthyes	(all)	75.0		
	Unknown	75.0	13.0	0.7
Detritus		37.5		0.8
Miscellaneous		50.0		8.3
			Total organisms = 46	Total weight = 39.3 g

Stomachs were obtained from 93 goldeye (mean length = 260 mm, 146 – 353 mm; mean weight = 157 g, 25 – 325 g), and only one stomach (1.1%) was empty. Orthopterans were found in 71.7% of the stomachs, and comprised 86.1% of the ingested organisms (Table 16). Six additional insect orders (Coleoptera, Hemiptera, Lepidoptera, Odonata, Plecoptera, Trichoptera) were also found in the diet (frequency of occurrence = 1.1 – 18.5%), but these cumulatively comprised less than 9.0% of the ingested organisms. Fish, horsehair worms (Class Gordoida, Order Nematomorpha), and mammals were found in 1.1 – 14.1% of the stomachs. Orthopterans comprised 90.8% of the weight of ingested organisms

Table 16. Frequency of occurrence (%, number of individuals containing the specific food item/ number of stomachs containing food), numerical frequency (%, total number of taxon-specific food items/total number of all food items), and weight frequency (%, total weight of a taxon-specific food item/total weight of all food items) of diet components for goldeye sampled in the Missouri River during July and August 2002. T = less than 0.1%.

Diet component		Frequency of occurrence (%)	Frequency by number (%)	Frequency by weight (%)
Insecta	Coleoptera	18.5	5.3	0.8
	Hemiptera	8.7	1.1	0.5
	Lepidoptera	2.2	0.2	0.3
	Odonata	1.1	0.1	T
	Orthoptera	71.7	86.1	90.8
	Plecoptera	1.1	0.1	T
	Trichoptera	12.0	2.1	T
	Unknown	14.1	2.0	1.9
Gordioda	Nematomorpha	1.1	0.1	T
Mammalia		1.1	0.1	1.4
Osteichthyes	(all)	14.1		
	Unknown	14.1	2.6	1.8
Detritus		7.6		0.1
Miscellaneous		19.6		2.3
			Total organisms = 808	Total weight = 492.23 g

Stomachs were acquired from 47 northern pike (mean length = 573 mm, 406 – 835 mm; mean weight = 1,180 g, 450 – 3,525 g), but 16 stomachs (34.0%) were empty. Fish were found in 64.5% of the stomachs (Table 17). Identifiable fish prey included centrarchids (i.e., sunfishes), ictalurids (i.e., catfishes), sauger, and Stizostedion sp. (i.e., walleye or sauger). Northern pike also consumed decapods (12.9% of the stomachs) and orthopterans (3.2% of the stomachs). Unknown fish had the highest frequency by number (75% of organisms ingested). Fish comprised 92% of the weight of ingested organisms, but the high percentage was largely due to one ingested sauger that comprised 78.5% of the total weight.

Table 17. Frequency of occurrence (%, number of individuals containing the specific food item/ number of stomachs containing food), numerical frequency (%, total number of taxon-specific food items/total number of all food items), and weight frequency (%, total weight of a taxon-specific food item/total weight of all food items) of diet components for northern pike sampled in the Missouri River during July and August 2002. T = less than 0.1%.

Diet component		Frequency of occurrence (%)	Frequency by number (%)	Frequency by weight (%)
Crustacea	Decapoda	12.9	8.3	7.5
Insecta	Orthoptera	3.2	6.3	0.2
Osteichthyes	(all)	64.5		
	Centrarchidae	3.2	2.1	0.2
	Ictaluridae	3.2	2.1	0.1
	Sauger	6.5	4.2	78.5
	Stizostedion	3.2	2.1	0.1
	Unknown	54.8	75.0	13.1
Detritus		12.9		0.1
Miscellaneous		29.0		0.3
			Total organisms = 48	Total weight = 349.23 g

Stomachs from 102 sauger (mean length = 368 mm, 206-526 mm; mean weight = 404 g, 50 – 1,275 g) were obtained, and 40 stomachs (39.2%) were empty. Fish represented the highest frequency of occurrence (93.5% of all stomachs); whereas, identifiable insects and crustaceans were found in only 1.6% to 3.2% of the stomachs (Table 18). Identifiable fish in the diet included common carp, emerald shiner, flathead chub, goldeye, *Hybognathus* sp., and ictalurids. Identifiable fish and unknown fish cumulatively comprised 85.7% of the total number of organisms found in the stomachs, and 98.5% of the total weight of organisms.

Table 18. Frequency of occurrence (%, number of individuals containing the specific food item/ number of stomachs containing food), numerical frequency (%, total number of taxon-specific food items/total number of all food items), and weight frequency (%, total weight of a taxon-specific food item/total weight of all food items) of diet components for sauger sampled in the Missouri River during July and August 2002. T = less than 0.1%.

Diet component		Frequency of occurrence (%)	Frequency by number (%)	Frequency by weight (%)
Insecta	Coleoptera	1.6	1.1	T
	Ephemeroptera	1.6	1.1	T
	Hemiptera	1.6	1.1	T
	Odonata	1.6	1.1	T
	Orthoptera	3.2	2.2	T
	Trichoptera	1.6	1.1	T
	Unknown	9.7	5.5	T
Crustacea	Argulus	1.6	1.1	T
Osteichthyes	(all)	93.5		
	Common carp	1.6	1.1	1.1
	Emerald shiner	6.5	4.4	12.3
	Flathead chub	4.8	3.3	50.2
	Goldeye	1.6	2.2	0.3
	Hybognathus	6.5	6.6	16.1
	Ictaluridae	1.6	1.1	5.8
	Unknown	82.3	67.0	12.7
	Eggs	1.6		T
Detritus		62.9		1.0
Miscellaneous		16.1		0.3
			Total organisms = 91	Total weight = 123.86 g

Stomachs from 64 shovelnose sturgeon (mean length = 563 mm, 162-722 mm; mean weight = 743 g, 100 – 1,350 g) were obtained. Of these, 5 stomachs (7.8%) were empty. The diet of shovelnose sturgeon was comprised primarily of insects (Table 19). Dipterans were the dominant insects consumed, and were found in 89.8% of the stomachs. Dipterans comprised 99.9% of the organisms consumed, and 87% of the weight of organisms in the stomachs.

Table 19. Frequency of occurrence (%, number of individuals containing the specific food item/ number of stomachs containing food), numerical frequency (%, total number of taxon-specific food items/total number of all food items), and weight frequency (%, total weight of a taxon-specific food item/total weight of all food items) of diet components for shovelnose sturgeon sampled in the Missouri River during July and August 2002. T = less than 0.1%.

Diet component		Frequency of occurrence (%)	Frequency by number (%)	Frequency by weight (%)
Insecta	Coleoptera	1.7	T	T
	Diptera	89.8	99.9	87.2
	Ephemeroptera	3.4	T	0.1
	Odonata	3.4	T	0.1
	Orthoptera	13.6	T	3.2
	Trichoptera	6.8	T	0.1
	Unknown	8.5	T	2.0
Crustacea	Decapoda	1.7	T	T
Detritus		5.1		T
Miscellaneous		11.9		7.1
			Total organisms = 85,965	Total weight = 249.20 g

Stomachs from 14 walleyes (mean length = 395 mm, 255 – 532 mm; mean weight = 609 g, 100 – 1,600 g) were obtained. Of these, 4 stomachs (28.6%) were empty. Fish were found in 80% of the stomachs, but fish prey could not be identified to species (Table 20). Although insects were present in the diet, fish comprised 84.6% of the total number of organisms and 98.6% of the weight of organisms in the stomachs.

Table 20. Frequency of occurrence (%, number of individuals containing the specific food item/ number of stomachs containing food), numerical frequency (%, total number of taxon-specific food items/total number of all food items), and weight frequency (%, total weight of a taxon-specific food item/total weight of all food items) of diet components for walleye sampled in the Missouri River during July and August 2002. T = less than 0.1%.

Diet component		Frequency of occurrence (%)	Frequency by number (%)	Frequency by weight (%)
Insecta	Ephemeroptera	10.0	7.7	0.1
	Odonata	10.0	7.7	0.5
Osteichthyes	(all)	80.0		
	Unknown	80.0	84.6	98.6
Detritus		40.0		0.5
Unknown		10.0		0.3
			Total organisms = 13	Total weight = 7.86 g

Related Activities

Incidental captures of adult and hatchery-raised juvenile pallid sturgeon.-Incidental captures of pallid sturgeon occurred in 2002 while conducting activities associated with the Fort Peck Data Collection Plan. First, an adult pallid sturgeon (1,362 mm, 12,150 g, PIT tag number 7F7D364B62) was sampled with a trammel net at rkm 2,600 (RM 1,615) on September 25. Second, a total of six hatchery-raised juvenile pallid sturgeon were sampled. Individuals were captured with trammel nets near Wolf Point on September 12 (231 mm, 38.9 g, PIT tag number 435E1D160C) and September 17 (245 mm, 44.1 g, PIT tag number 435D675A10), near Culberston on September 19 (416 mm, 211.7 g, PIT tag number 424F0D0226; 603 mm, 642.3 g, PIT Tag number 411D0B513C) and September 26 (369 mm, 176.5 g, no PIT tag, green and yellow elastomere implants), and at the Yellowstone River confluence on September 25 (430 mm, 243.0 g, PIT tag number 424F377447).

Young-of-year sturgeon sampling.-Benthic trawling was conducted between August 7 and September 5, 2002, to sample for young-of-year (YOY) sturgeon. Three riverine areas were sampled including the Missouri River above the Yellowstone River confluence (ATC; rkm 2,549-2,563, RM 1,583-1,592), the Yellowstone River (rkm 0-3.2, RM 0-2.0), and the Missouri River below the Yellowstone River confluence (BTC; rkm 2,497-2,547, RM 1,551-1,582). Young-of-year sturgeon (e.g., designated as less than 100 mm) sampled were measured in the field, preserved in a 10% formalin solution, and were tentatively identified as pallid sturgeon or shovelnose sturgeon in the laboratory using criteria established by Dr. Darrel Snyder (Colorado State University, Larval Fish Laboratory). If individuals were initially identified as pallid sturgeon, then they were sent to Dr. Darrel Snyder for expert identification.

A total of 116 benthic trawl samples was conducted among the three sampling areas resulting in a total of 475.5 minutes of sampling effort (Table 21). Three YOY sturgeon tentatively identified as shovelnose sturgeon were sampled in the Missouri River ATC on August 7, August 21, and September 4 (Table 21). These individuals varied from 20 – 58 mm. No YOY sturgeon were sampled from the Yellowstone River; however, sampling effort in the Yellowstone River was low in comparison to the other sites. A total of 30 YOY sturgeon was sampled in the Missouri River BTC (Table 21). The number of YOY sturgeon sampled was low (≤ 3 individuals) from August 13 to September 4, but increased to 20 on September 5. Two YOY sturgeon sampled from the Missouri River BTC exhibited characteristics specific to pallid sturgeon, and were tentatively identified as pallid sturgeon. These individuals were sampled on September 4 at rkm 2,537 (RM 1,576) and September 5 at rkm 2,500 (RM 1,553). The two individuals were sent to Dr. Darrel Snyder for species confirmation. The following quoted text from Dr. Snyder (dated 17 March 2003) highlights the results from his examination of the two YOY sturgeon:

"Based on my analyses, I have designated both specimens as tentative pallid sturgeon (*Scaphirhynchus albus*?). If these are pure pallid sturgeon, they display some characters observed only for shovelnose sturgeon in my comparison of hatchery reared larvae. However, I suspect they are impure pallid sturgeon or possibly F1 hybrids displaying mostly pallid sturgeon traits.

Both specimens were developmentally at or very near transition from the protolarval phase (without yolk) to the mesolarval phase and were therefore analyzed using criteria for both developmental phases; greater weight was given to criteria for protolarvae without yolk. The smaller specimen (21.6 mm TL, collected on 9/5/02 at H-85 site) has a torn caudal fin with a few rather indistinct or questionable caudal fin rays and no dorsal or anal fin rays. The larger specimen (23.1 mm TL, collected on 9/4/02 at US Erickson site) has a few "almost" distinct dorsal (but not caudal or anal) fin rays, depending on lighting and angle of view. Treated as protolarvae, both specimens matched pallid sturgeon criteria for all but one primary taxonomic character and about half of the secondary taxonomic characters. Treated as mesolarvae, criteria for all but one secondary character for both specimens and one primary character for the smaller specimen matched pallid sturgeon or both species. Had I analyzed the specimens only as mesolarvae, I would have designated the larger specimen positively as pallid sturgeon and the smaller specimen as unknown (probably a hybrid). Both specimens had fewer dorsal-fin pterygiophores than previously observed for larvae of either species. Considering the late date of capture relative to developmental state, it is possible that this and perhaps other meristic characters were affected by substantially warmer incubation and rearing temperatures than used for the developmental series I described. Results of the analyses are detailed on the following pages."

Table 21. Benthic trawl sampling locations, effort, dates, and number and lengths (minimum and maximum length in parentheses) of young-of-year sturgeon sampled in 2002. Asterisks denote that a pallid sturgeon was sampled. ATC = Missouri River upstream from the Yellowstone River confluence, BTC = Missouri River downstream from the Yellowstone River confluence.

		Date							
Location	Metric	8/7	8/13	8/21	8/22	8/27	8/28	9/4	9/5
Missouri River ATC	Effort (trawls)	8		12			9	5	
	Effort (minutes)	31		48			31	28	
	Number of sturgeon	1		1			0	1	
	Mean length	38		58				20	
Missouri River BTC	Effort (trawls)		21		22	18		10	6
	Effort (minutes)		81.5		85.5	69		50	32
	Number of sturgeon		1		3	3		3*	20*
	Mean length		58		49 (22-81)	29 (15-55)		24 (22-25)	21 (17-25)
Yellowstone River	Effort (trawls)				5				
	Effort (minutes)				19.5				
	Number of sturgeon				0				
	Mean length								

Other researchers have sampled larval pallid sturgeon in the Mississippi River (R. Hrabik, Missouri Department of Conservation, Jackson, MO, personal communication) and the lower channelized Missouri River (L. Mauldin, USFWS, Columbia, MO, personal communication). The two larval pallid sturgeon sampled in September 2002 provide the first documented account of larval pallid sturgeon in the Missouri River downstream from Fort Peck Dam, and indicate that successful spawning by pallid sturgeon did occur in 2002. However, it is not known whether spawning occurred in the Yellowstone River or in the Missouri River. Additional analyses will be conducted on the two larval pallid sturgeon to estimate age, hatch date, and spawning date.

Activities for 2003

All monitoring activities associated with the Fort Peck Data Collection Plan will continue through the 2003 field season with the exception of the piscivore food habit studies. The piscivore food habit studies will be initiated again when the full-test of the spillway releases is implemented. In addition to the monitoring activities, we will continue to sample for YOY pallid sturgeon and shovelnose sturgeon during August and September. Funding for the Fort Peck Data Collection Plan was expanded for 2003 to conduct a larval sturgeon drift study in the Missouri River downstream from Fort Peck Dam. This is a collaborative study involving the MTFWP (Dave Fuller), USGS Columbia Environmental Research Center, Fort Peck Project Office (Pat Braaten), and the USGS Conte Anadromous Fish Research Center (Boyd Kynard) designed to evaluate drift rates, drift distance, and drift behavior of larval pallid sturgeon and larval shovelnose sturgeon through a range of water velocities and environmental conditions. Results from this study will be presented at the annual Upper Basin meeting in December 2003.

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